AFWL-TR-83-52

FRAGMENT HAZARDS ON PRE-DIRECT COURSE

Robert L. Guice, Captain, USAF

January 1984

Final Report

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THIS RESEARCH WAS SPONSORED BY THE DEFENSE NUCLEAR AGENCY UNDER SUBTASK H42BAXYX, WORK UNIT 0010, GENERAL SUPPORT WORK.

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Kirtland Air Force Base, NM 87117

AFWL-TR-83-52

This final report was prepared by the Air Force Weapons Laboratory, Kirtland Air Force Base, New Mexico, under Job Order WDNS9217. Lt Steven D. Wert (NTED) was the Laboratory Project Officer-in-Charge.

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UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) AFWL-TR-83-52	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Air Force Weapons Laboratory — 6b. OFFICE SYMBOL (If applicable) NTED	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State and ZIP Code) Kirtland AFB NM 87117	7b. ADDRESS (City, State and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION Defense Nuclear Agency — 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State and ZIP Code) Washington DC 20305	10. SOURCE OF FUNDING NOS. PROGRAM ELEMENT NO. 62715H; PROJECT NO. WDNS; TASK NO. 92; WORK UNIT NO. 17
11. TITLE (Include Security Classification) FRAGMENT HAZARDS ON PRE-DIRECT COURSE (U)	

12. PERSONAL AUTHOR(S)
Robert L. Guice, Captain, USAF

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Yr., Mo., Day)	15. PAGE COUNT
Final Report	FROM Jan 82 TO Mar 83	1984, January	265

16. SUPPLEMENTARY NOTATION
This research was sponsored by the Defense Nuclear Agency under subtask H42BAXYX, Work Unit 0010, General Support Work.

17. COSATI CODES FIELD	GROUP	SUB. GR.	18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
19	02		High explosives; Pre-DIRECT COURSE; Fragmentation
19	04		Gurney constants

19. ABSTRACT (Continue on reverse if necessary and identify by block number)
An effort has been made to predict, identify and measure fragments and their trajectories for the Pre-DIRECT COURSE event. A method does not exist which will perform the task by itself. Various predictive techniques exist from other work areas which, with care, can be applied to the case of interest. Experimental techniques exist which aid in verifying the predictive methods, but these tend to be expensive if all variables are to be defined.

The predictive analysis as derived by Bishop results in the best prediction. Impact probabilities from Pre-DIRECT COURSE reveal that a person must be located out of a 130.3 m radius from ground zero to meet a safety criteria of less than one impact in one million. The factor of increase in fragment trajectories from Pre-DIRECT COURSE to DIRECT COURSE is calculated to be 1.0687.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS ☐	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Lt Steven D. Wert	22b. TELEPHONE NUMBER (Include Area Code) (505) 844-0262 — 22c. OFFICE SYMBOL AFWL/NTED

DD FORM 1473, 83 APR — EDITION OF 1 JAN 73 IS OBSOLETE.

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PREFACE

The author would like to record his appreciation to Messrs Bruce Schneider, Paul Reining, Ruel Thompson, Curtis Burnett, Guy Bock, and Gene Ross of New Mexico Engineering Research Institute for their assistance in marking the structure and searching for fragments in the bushes. Thanks is also extended to Maj Ray Bell, AFWL/NTEDA, for his E-P HULL assistance, and to Capt Stan Lokaj, AFWL/NTESA, for his conventional weaponry expertise.

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A height-of-burst (HOB) test such as Pre-DIRECT COURSE creates more areas of interest than simply shock phenomenology. To obtain a known HOB experiment with a high-explosive charge some type of support structure is required. This support structure may cause hazards from fragments. The fragments are a result of the large intensity blast and thermal loading of the support structure. Given a certain set of initial conditions a fragment could be capable of traveling tens of thousands of meters.

Many locations in the test area require that personnel be present, operating equipment or conducting the test (i.e., instrumentation vans, administration vans, laser bunker, weather station, and observation area). The possible presence of fragments then creates safety hazards and individual experiment hazards. Possibilities will exist for gages or objects to receive damage from fragment impact.

This effort will attempt to predict the quantity, velocity, and range of fragments present. To verify the predictions, high resolution photographic coverage will be utilized during the event from both ground surface and aerial platforms. The final phase of the effort will consist of a posttest ground search and documentation of the recovered fragments.

II. DESIGN OF THE EXPERIMENT

Design of Support Structure--To support the 2.177×10^4 kg (24 tons) of explosives at a height of 17.37 m (57 ft) an extensive design effort was initiated. Considering all of the design factors, (i.e., cost, fidelity, constructability, safety, etc.) a single, guyed, battened column was chosen as the best concept (Fig. 1). This column extends from the ground surface to a point just below the charge surface. Attached to the top of the battened column is a fiberglass column. The fiberglass column passes through the sphere of explosives and extends 1.29 m (4.25 ft) above the explosives. On top of the fiberglass column is an upper steel column 2.44 m (8 ft) long.

The explosives are held, with the center at 17.37 m, in a spherical geometry by a fiberglass container. This container is supported in place by a polyester webbed net which, in turn, is connected to a series of wire ropes which transfer the load to the top of the upper steel column (Fig. 2).

Fragments--All of the members making up the support structure will create fragments of some type, but not all of them will create safety hazards. The upper portion of the lower battened column will receive tremendous loadings from the blast and thermal environments. As was seen at the preliminary test, FRED II, the upper one-third of the battened steel column was stripped and scattered (Ref. 1). However, these fragments are scattered at small ranges from ground zero. This part of the support structure will not cause safety hazards since the fragments will be directed downward due to their initial location, underneath the charge. The maximum ranges from these fragments will probably be gained from bounces (after the fragment has initially struck the concrete radials). The major hazards these fragments would produce would be to various experiments in the region from ground zero to approximately two HOBs. These fragments when initially impacting the ground could have velocities up to hundreds of meters per second and, thus, create substantial damage.

The fiberglass column and container will produce fragments, but will not create substantial safety or experiment hazards. These fragments may obtain velocities up to thousands of meters per second, but due to their low mass will not carry much momentum (relative to the steel members). The major hazards would be to transmission experiments or direct measurement devices.

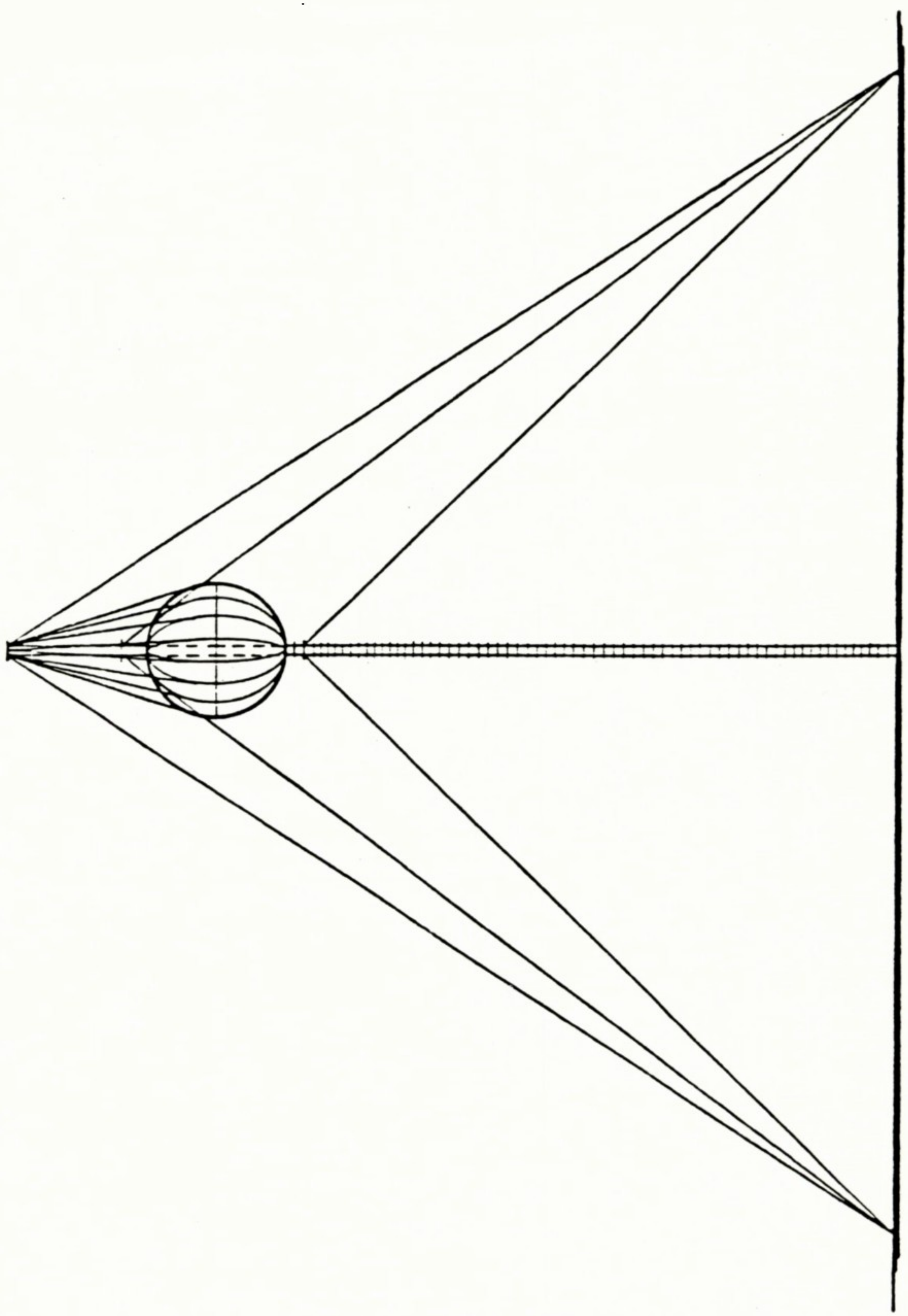


Figure 1. Pre-DIRECT COURSE concept.

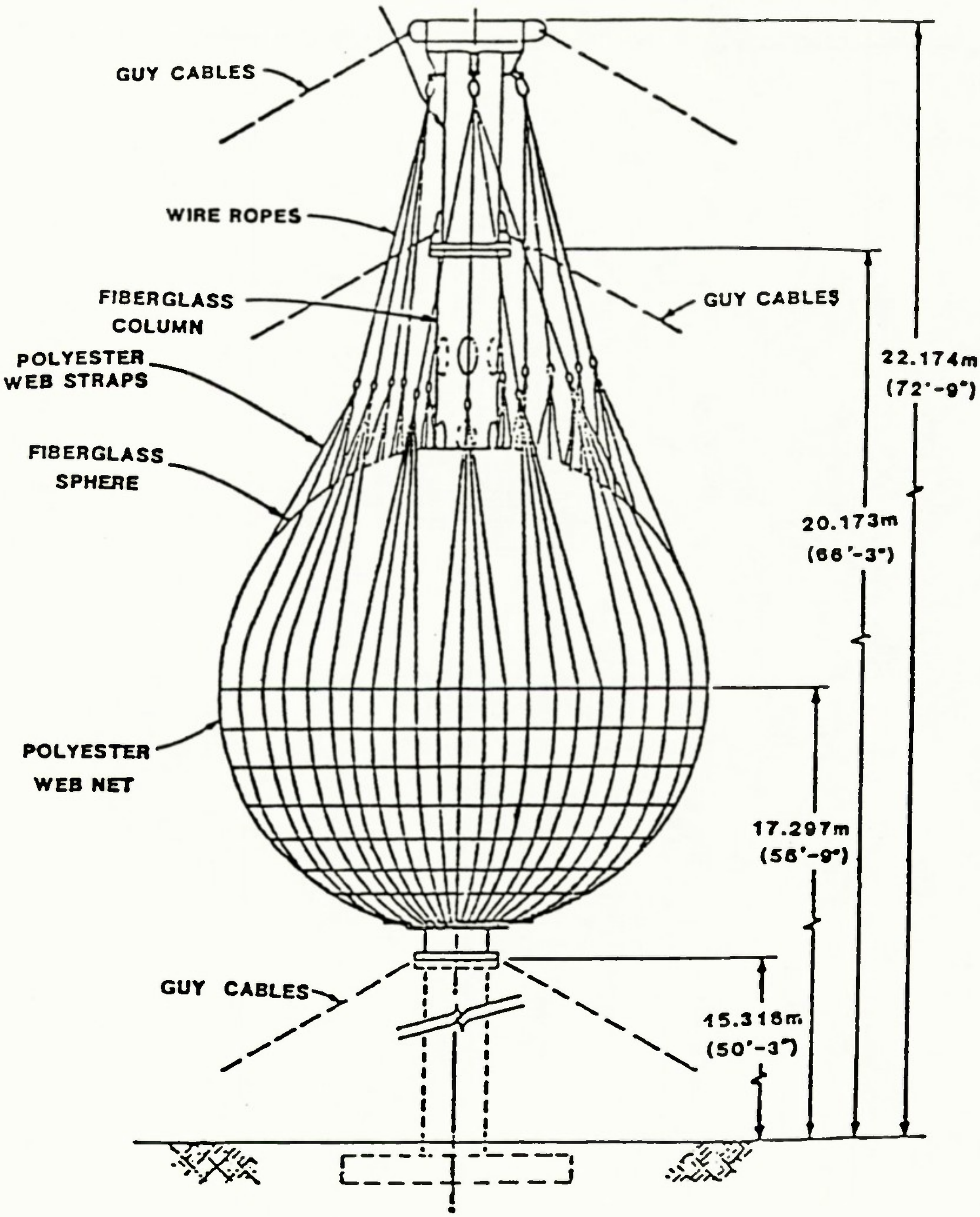


Figure 2. Upper portion of support structure.

The remaining support structure member (the upper steel column) has the greatest potential for creating safety hazards. Included in the fragments from this column are the hooks, rings, and bolts which connect the polyester net, wire ropes, and guy cables. Since all of these objects are located above the charge surface, their potential for long flights is the greatest of any member of the support structure.

Upper Steel Column--The upper steel column is essentially a standard 40.64 cm (16 in) outer diameter steel pipe 2.439 m (8 ft) long with 0.95 cm (3/8 in) walls. Welded to the pipe are various flanges and brackets for connecting guy and wire rope cables (Fig. 3).

The pipe is ASTM-53A steel having a yield strength of 2.482×10^8 Pa (36 ksi), which represents approximately 60 percent of the ultimate strength. Flanges and plates are also ASTM-53A steel, and are attached with welds with a strength of 4.826×10^8 Pa (70 ksi) making, in essence, a stronger material at connection points than the steel material itself.

Method of Fragmentation--Due to the design of the center fiberglass column, it is assumed that the interior of the column will act as a shock tube confining a portion of the upward flow to two dimensions or less. The flow outside of the column will be fully three-dimensional and diverge spherically. This difference would allow the flow inside the column to decelerate slower than the exterior flow, if friction and other small losses are neglected. Assume that the shocked flow has propagated for some amount of time and reached the upper steel column. The shock which has been confined by the shock tube effect would be loading the interior of the pipe prior to the loading of the pipe's exterior. This pressure differential could result in a loading gradient which could stress the pipe section to a point of fracture. Fortunately, the majority of the pipe surface is parallel to the direction of the flow and receives most of the loading from static pressures and little from dynamic pressures. The flanges and plates, however, would receive a larger loading due to the stagnation of the flow.

Many problems are faced when trying to predict the fragmentation. Also, the environment at these close ranges is nearly undefinable. There is no

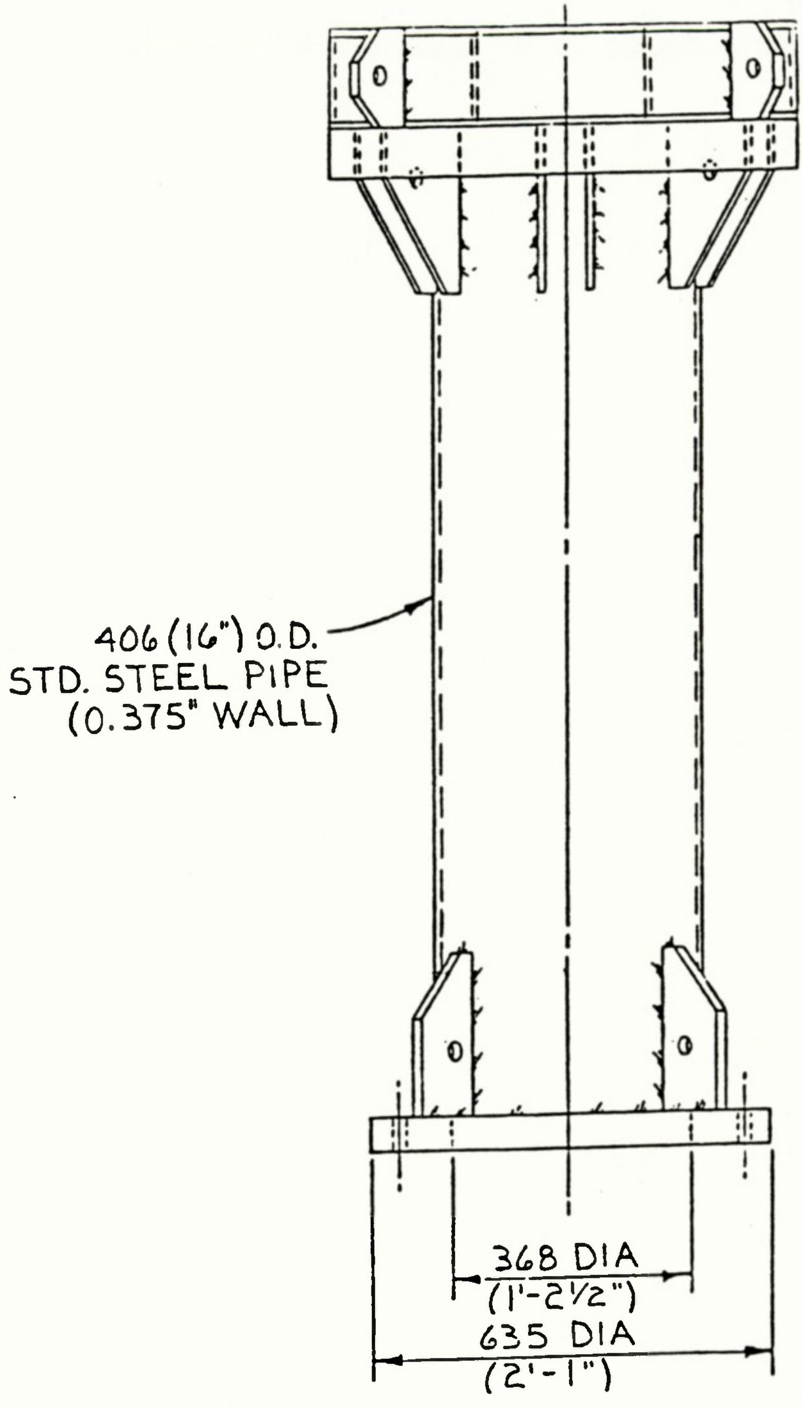


Figure 3. Upper steel column.

documented evidence of recorded pressures or impulses at ranges of 1.37 m to 3.809 m (4.5 ft to 12.5 ft) from the surface of a large, high explosive charge. Photographic data may be obtained relating to the temperatures and velocities, but these data, at the ranges of interest, cannot be used to deduce pressure or density information. Normal shock relations are not valid since the shock and fireball are still attached. The only means to obtain information is from theoretical or hydrocode calculations. But, once again, at these regions, these numerical data have not been validated.

There is no documented evidence of any method to predict random fragmentation of any material. Hydrocodes, such as Elastic-Plastic HULL (Ref. 2), are available which can model the steel members and the explosive material. However, the most these calculations will reveal is the maximum stress and strains, and the energy transfer into the materials, and nothing about fragment shapes or sizes. This information, about the strain and stresses, can be useful to determine if the member will be loaded beyond its ultimate strength.

Conventional weapon research does reveal some information concerning fragment trajectories if the explosive weight, casing parameters, and materials are known. Once again, these methods reveal little information about fragment sizes or shapes. Another problem with using conventional weaponry research is the absence of any data with low explosive characteristics (i.e., detonation pressures and velocities) such as Ammonium Nitrate and Fuel Oil (ANFO).

Past large-scale testing and results from any conventional measurement schemes do not reveal any information on break-up of close-in structures. The structures in these close-in regions are engulfed by the fireball before any noticeable failure or movement occurs. There are two methods by which some data could be gained which are infrared photography and Doppler radar transmission. However, the resolution of the infrared photography is too poor to give adequate break-up data and the radar transmission is hard to field and very expensive.

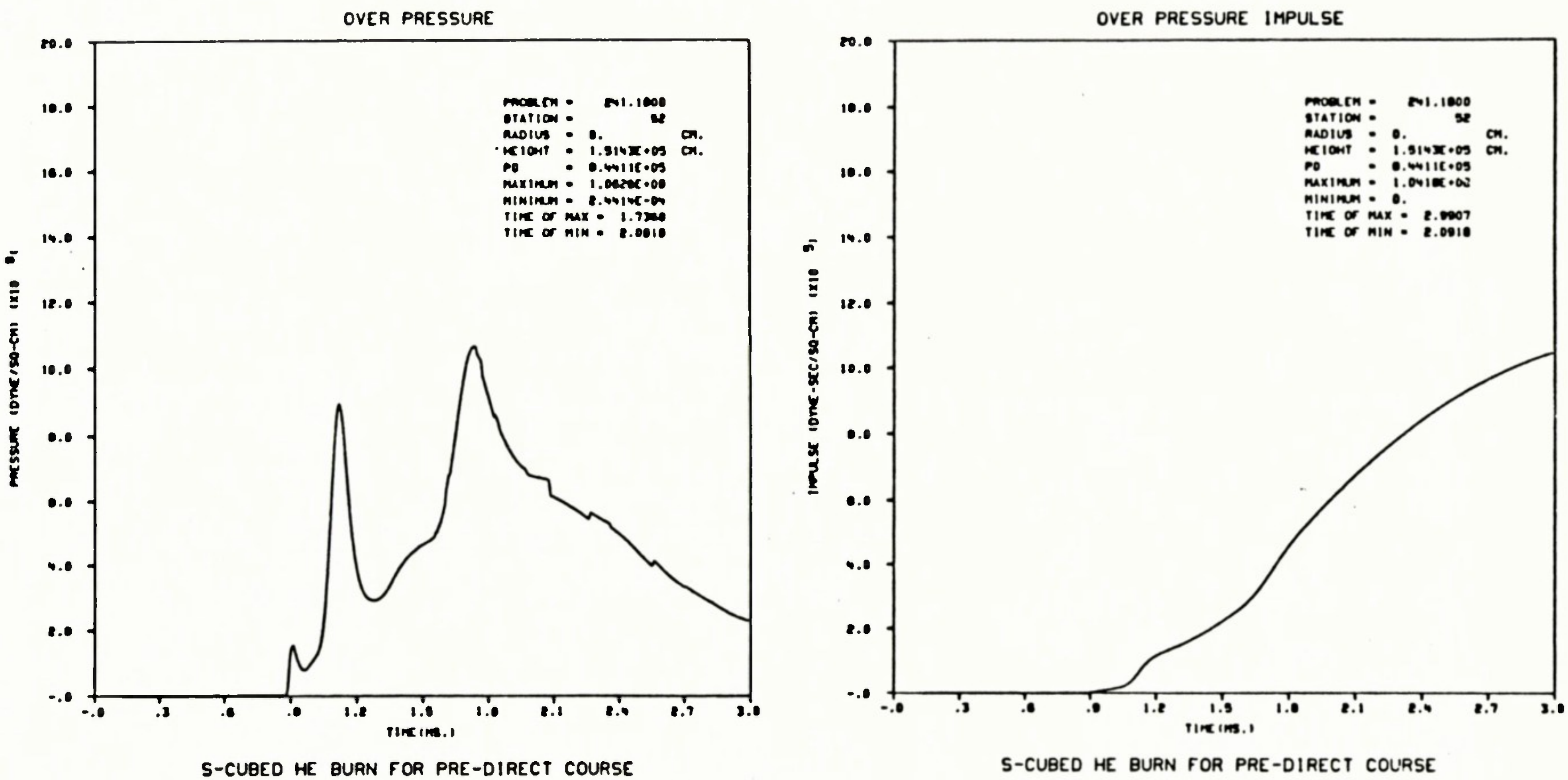
Given these obstacles an attempt was made to use bits and pieces of the various methods to predict the fragment parameters.

Calculation Methods--As previously mentioned there is no evidence of one method to cover the entire scope of this effort. Analytical and empirical methods are available for predicting high-explosive environments. Methods are available for predicting environment and target interactions. Other methods also exist for predicting fragment trajectories. However, none of these methods have been coupled together nor can they predict a material's dissassembly or fragmentation.

The HULL hydrodynamics code has gained international recognition for its fairly accurate results in predicting high-explosive environments (Ref. 3). S-CUBED conducted HULL calculations of the Pre-DIRECT COURSE event. Data from the calculation at 1.5, 2, and 3 m above the charge surface are presented in Figures 4a through 4o and peak values are summarized in Table 1 (Ref. 4). These data reflect semifree-field data. Specifically, the plots indicate the environments in a modeled pipe above the charge surface. The pipe is nonreactive with the environment, with the exception of being able to reflect the flow off its walls. These data were received too late to be included in the predictions for this effort, but are presented solely for completeness.

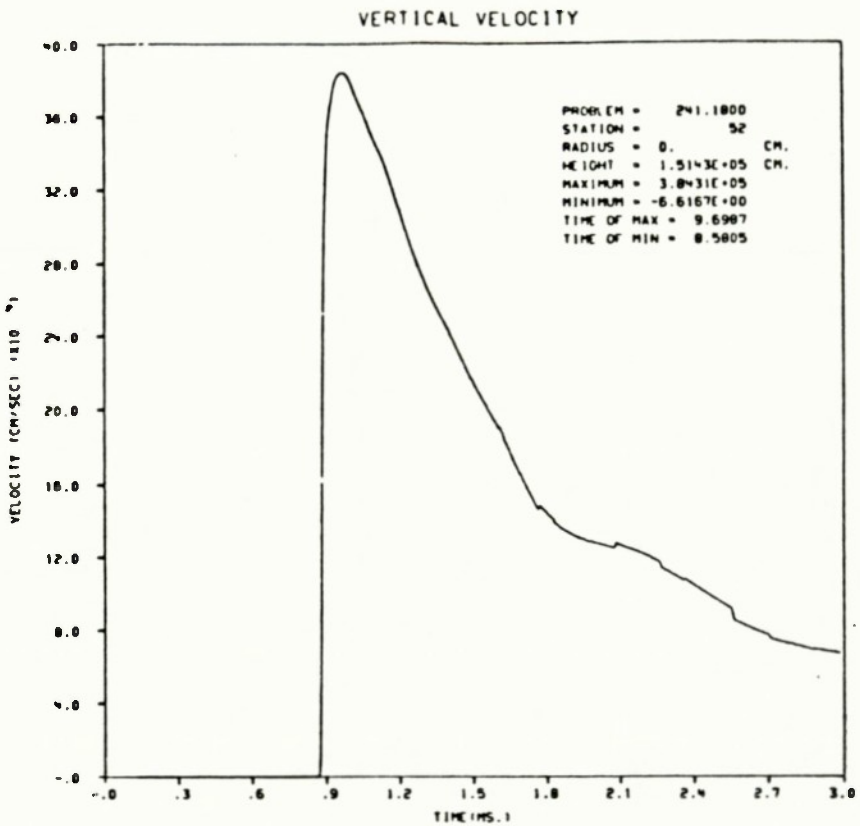
One hydrodynamic method which was utilized as a source of initial conditions was the Elastic-Plastic HULL Code. This calculation, performed at the Air Force Weapons Laboratory (AFWL), modeled the explosive charge and the upper support column, complete with flanges. The fiberglass around the charge and the center column was not modeled. This calculation, problem No. 40040.0010, consisted of a cylindrical coordinate system with close-in cell dimensions of 5 cm radially by 5 mm vertically. The explosive modeled was ANFO and the steel was ASTM-53A.

Figure 5 shows a density plot at 500 μs. The upper support column and the shock/fireball location can be identified (the mesh is originated at the center of the charge). At this point in calculation time the detonation wave has propagated through the charge and the shock/fireball has grown by 80 cm. Figures 6 through 10 show additional density and velocity vector plots from the calculation. One of the many drawbacks to hydrodynamic calculations is their enormous cost; for this reason this calculation was ended near 1 ms. At this point the calculation indicated that the center of mass of the steel had



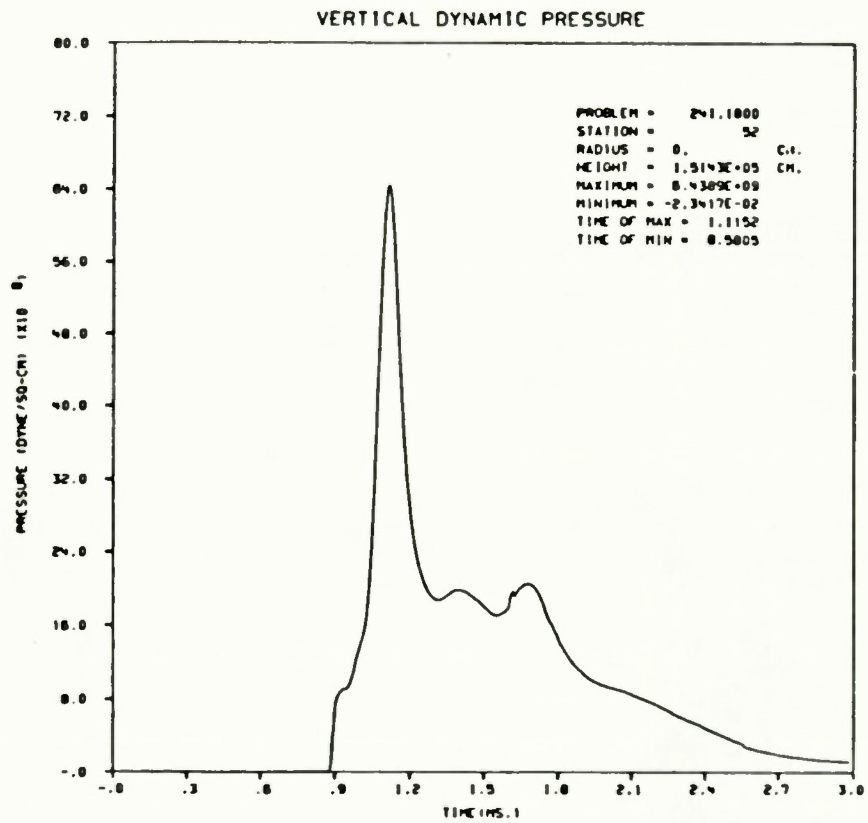
(a) (b)

Figure 4. Calculation results.



S-CUBED HE BURN FOR PRE-DIRECT COURSE

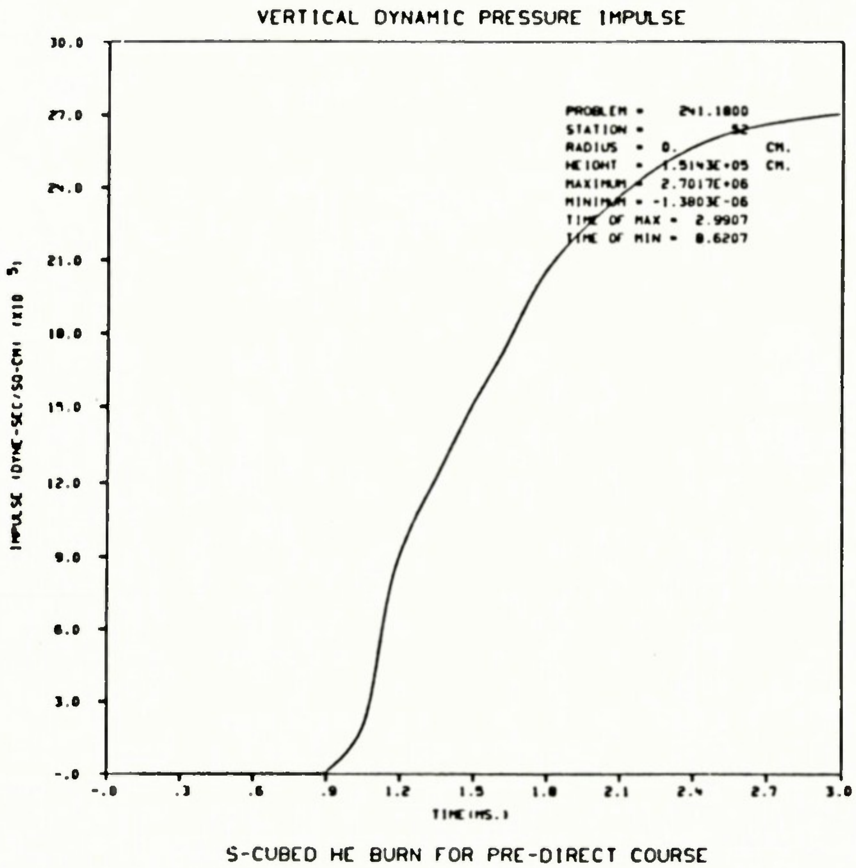
(c)



S-CUBED HE BURN FOR PRE-DIRECT COURSE

(d)

Figure 4. Continued.



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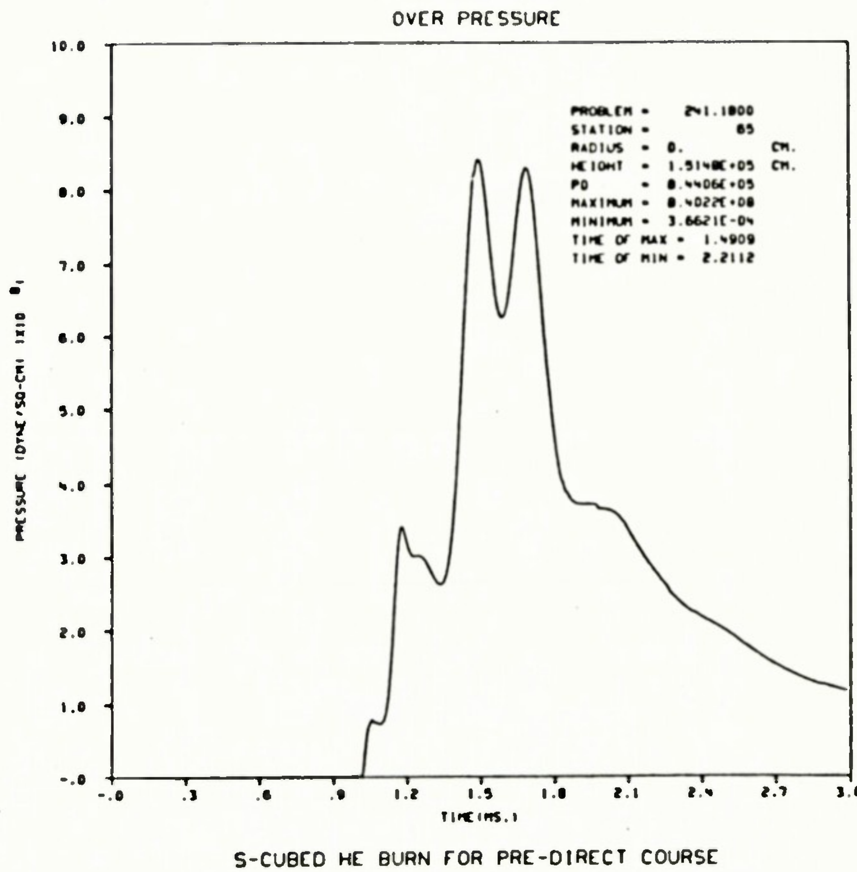

(f)

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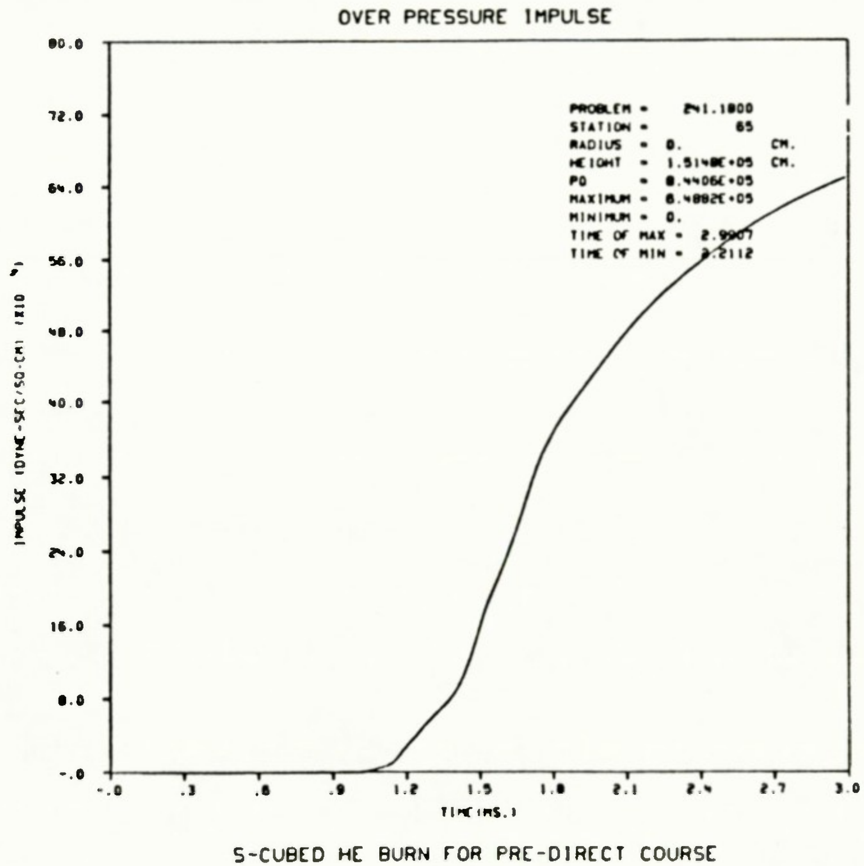
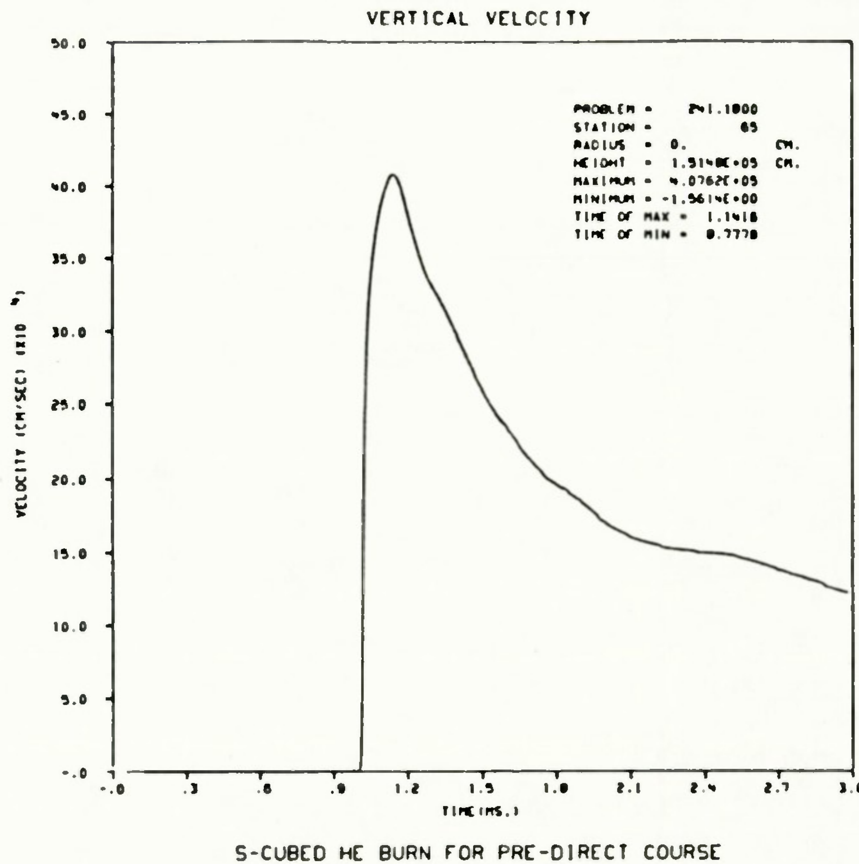


(g)



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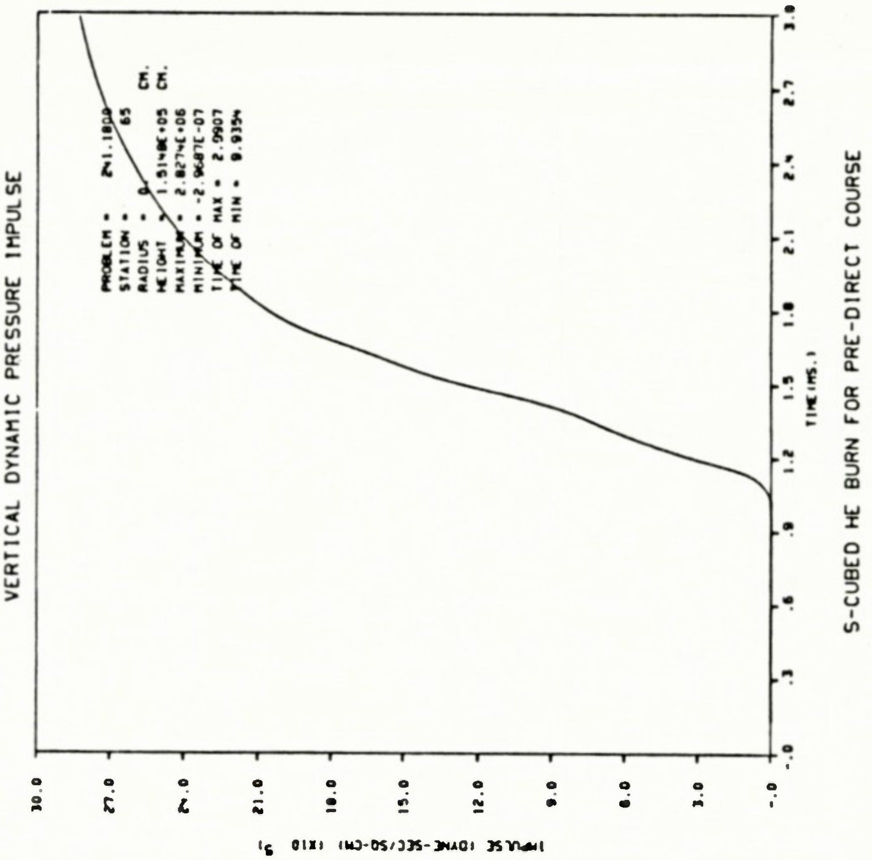

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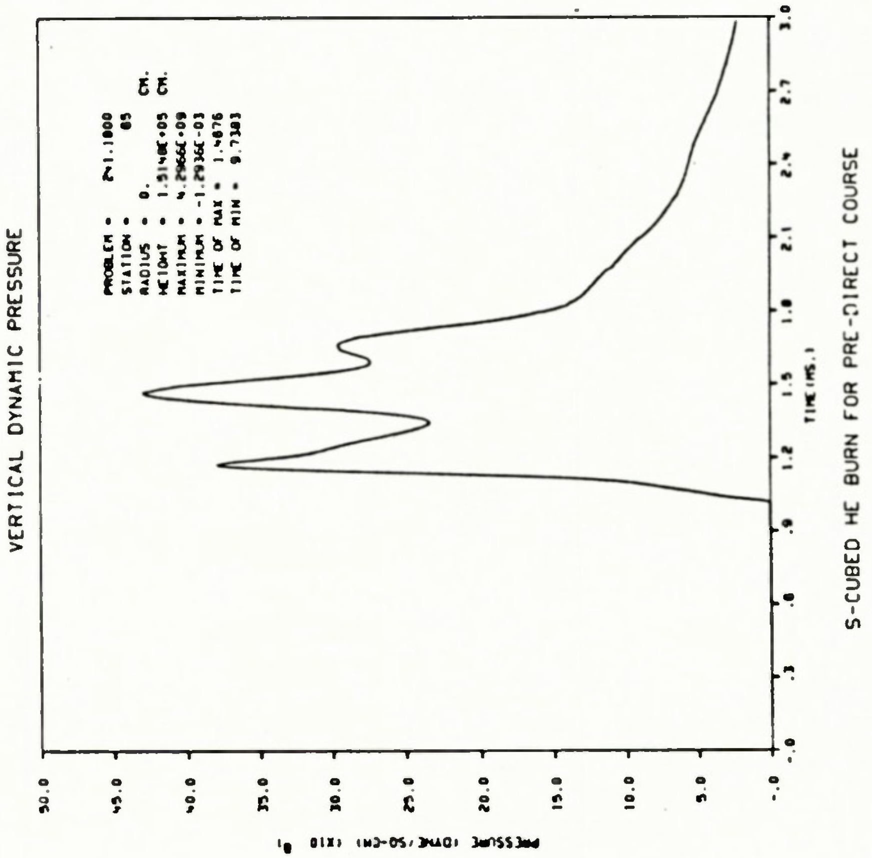
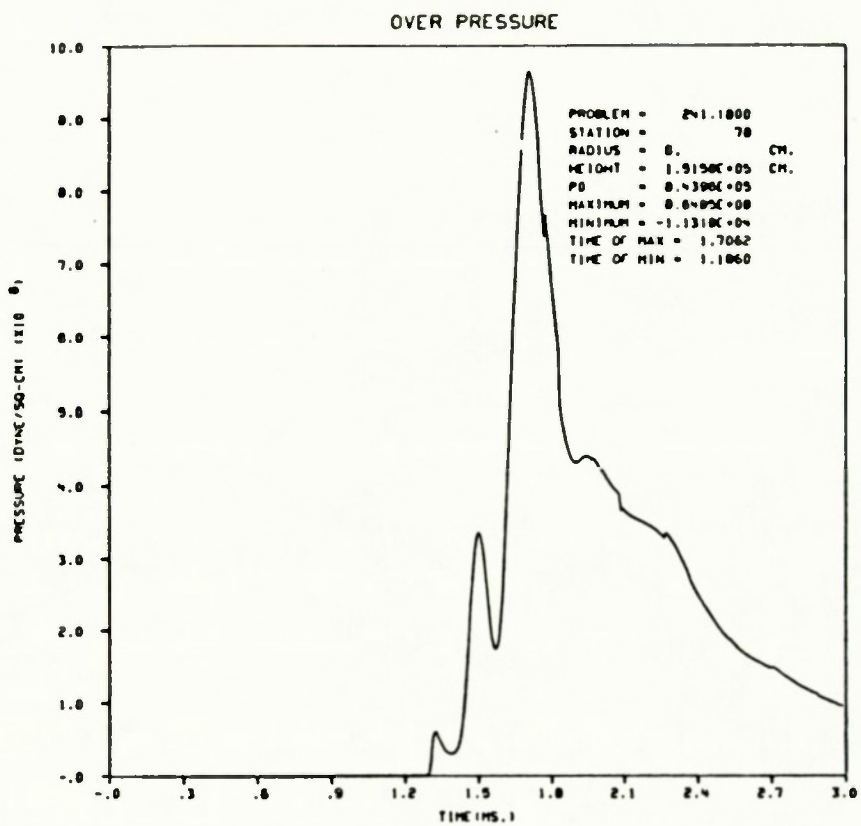


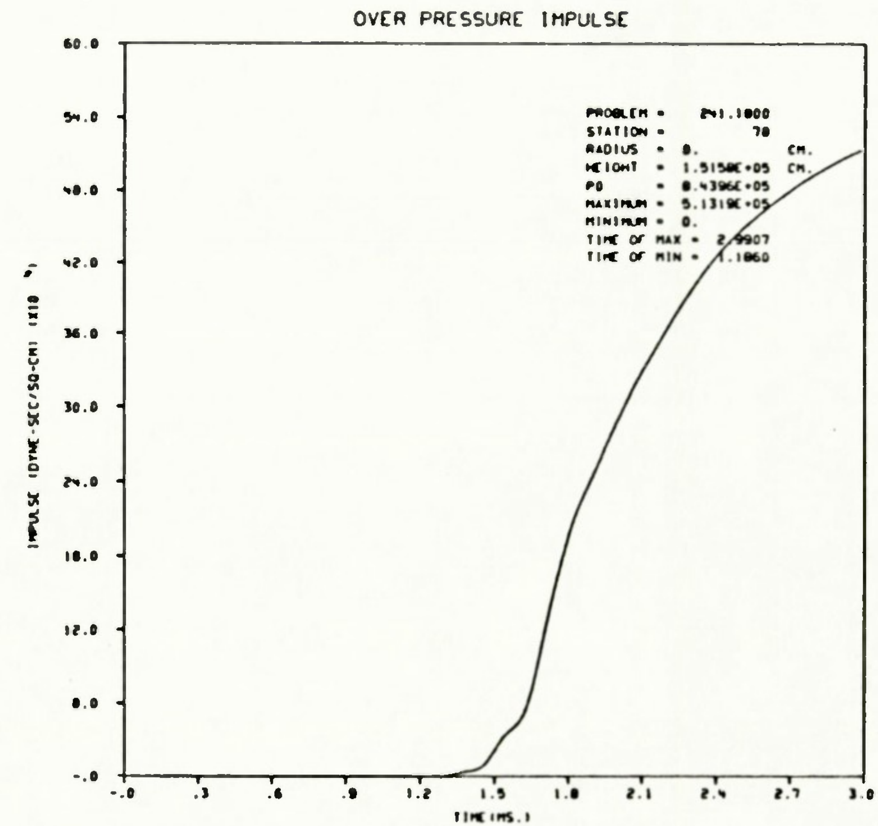
(i)

Figure 4. Continued.



S-CUBED HE BURN FOR PRE-DIRECT COURSE

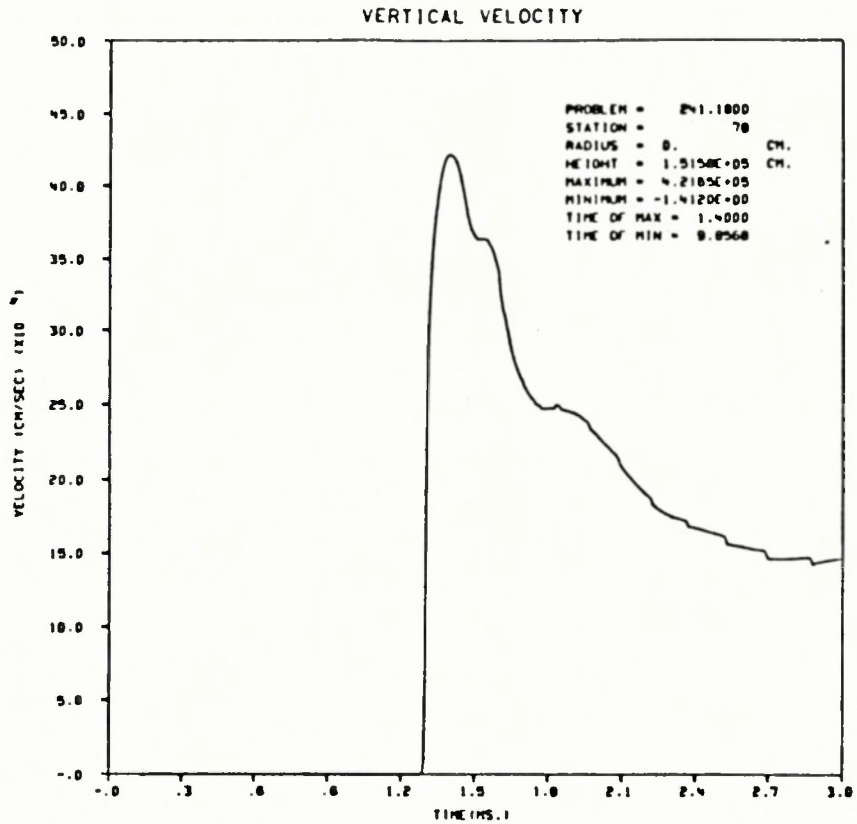
(k)



S-CUBED HE BURN FOR PRE-DIRECT COURSE

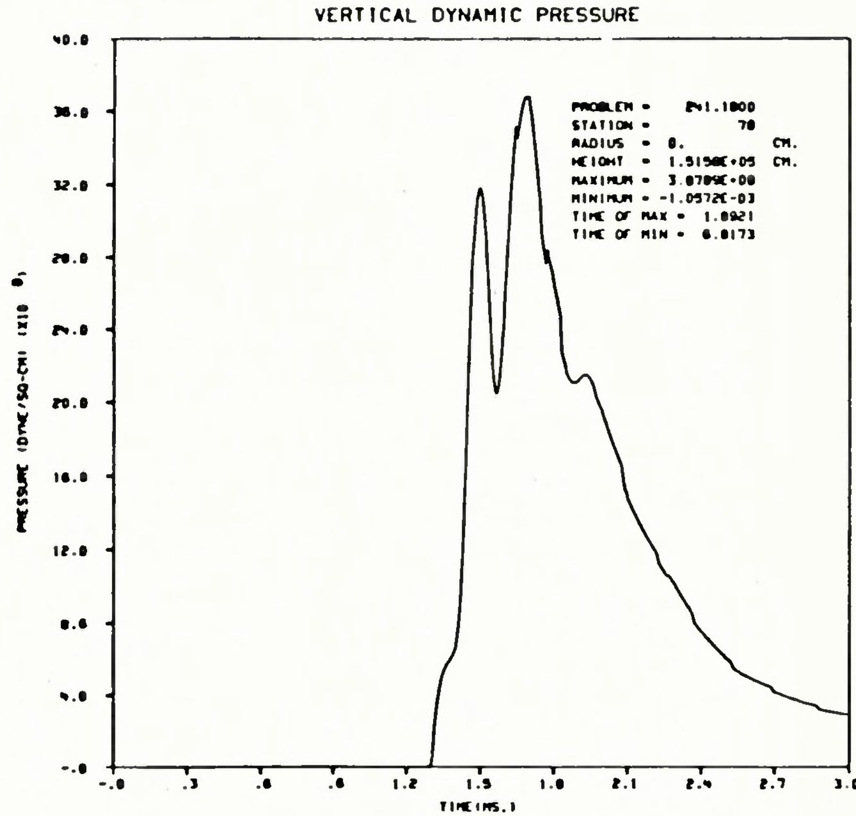
(l)

Figure 4. Continued.



S-CUBED HE BURN FOR PRE-DIRECT COURSE

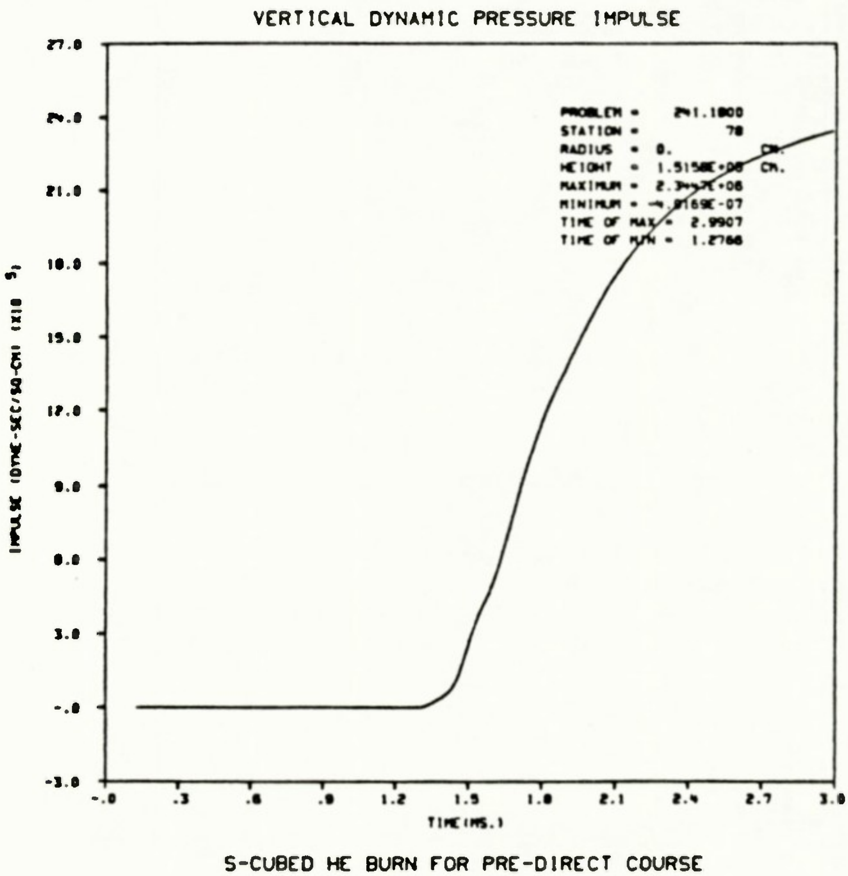
(m)



S-CUBED HE BURN FOR PRE-DIRECT COURSE

(n)

Figure 4. Continued.



(o)

Figure 4. Concluded.

TABLE 1. S-CUBED Pre-DIRECT COURSE CALCULATION

Station Number	X-coord (m)	Y-coord (m)	Time of Shock Arrival (msec)	Incident Pressure Peak (Pa)	Maximum Peak Pressure (Pa)
52	1.5143×10^3	0.0	0.858	1.5×10^7	10.6×10^7
65	1.5148×10^3	0.0	0.974	0.8×10^7	8.4×10^7
78	1.5158×10^3	0.0	1.29	0.6×10^7	9.64×10^7

Station Number	Impulse @ 3 ms (Pa-s)	Peak Vertical Velocity (m/s)	Peak Vertical Dynamic Press (Pa)	Vertical Dyn Press Impl (Pa-s)
52	1.04×10^5	3.84×10^3	6.438×10^8	2.701×10^5
65	8.44×10^5	4.07×10^3	4.29×10^8	2.827×10^5
78	0.51×10^5	4.21×10^3	3.68×10^8	2.34×10^5

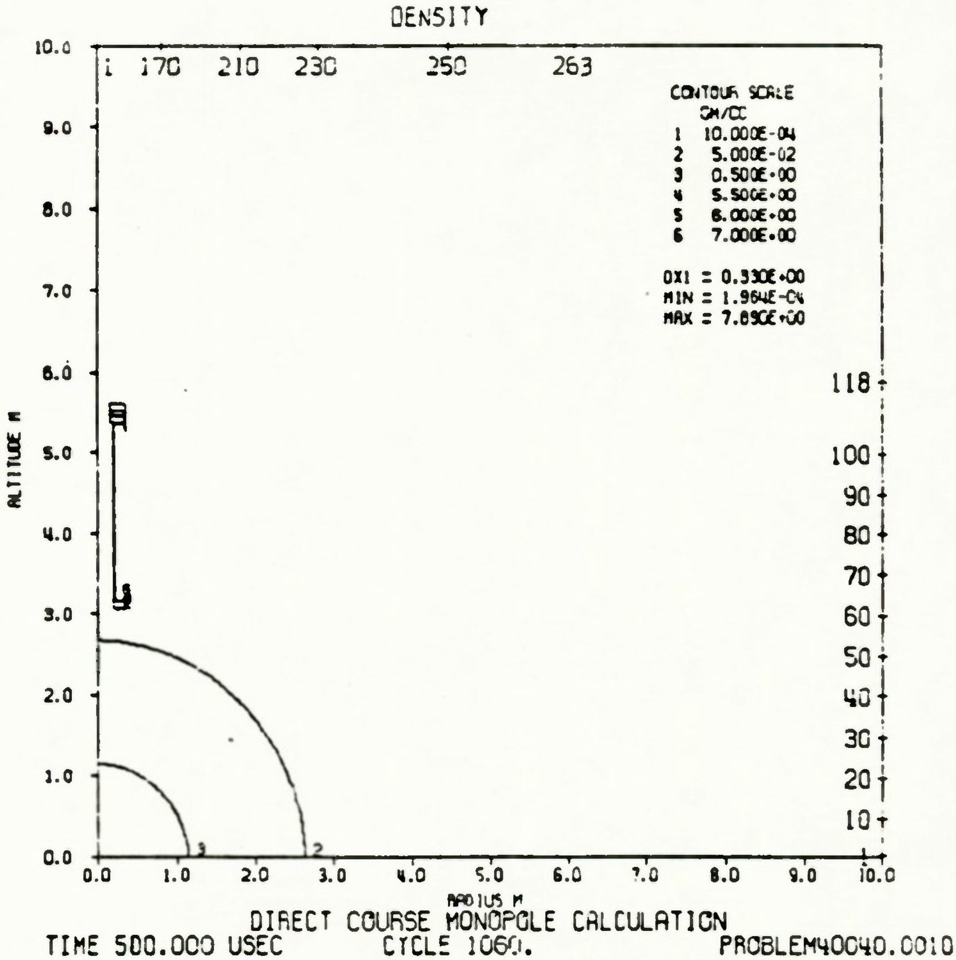


Figure 5. E-P HULL density results at 500 μs.

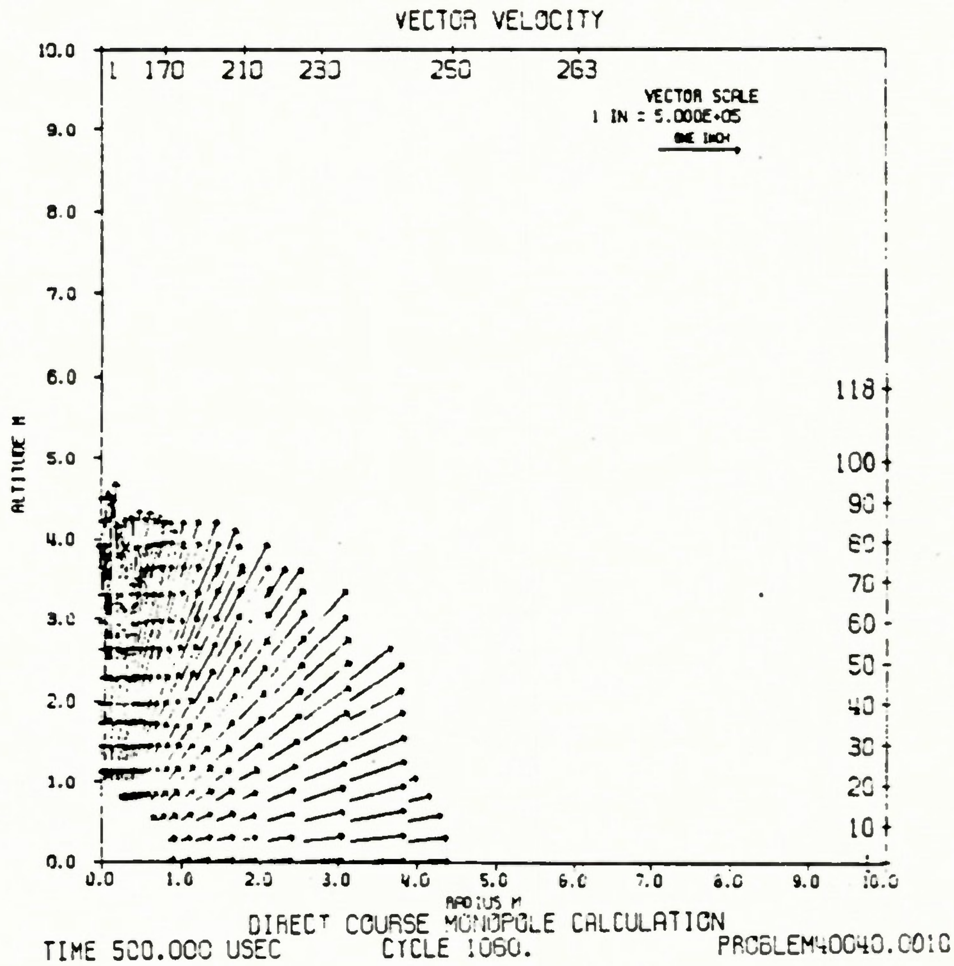


Figure 6. E-P HULL vector velocity results at 500 μs.

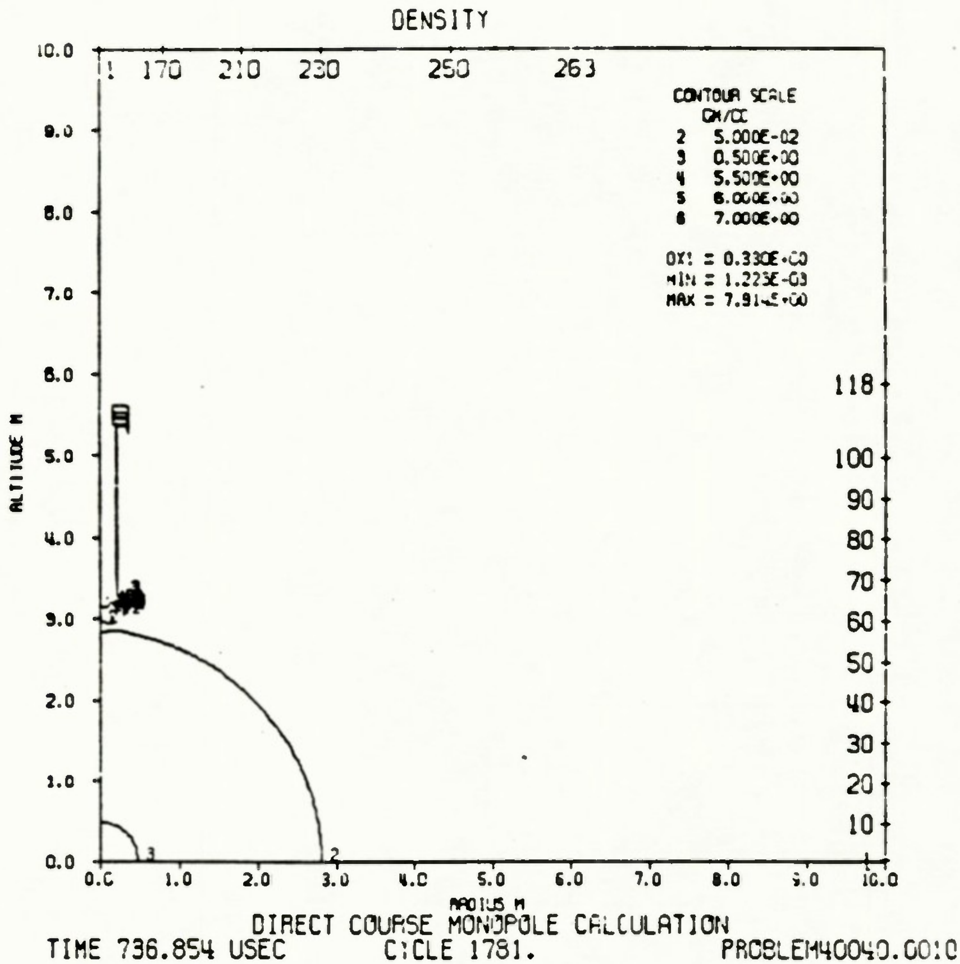


Figure 7. E-P HULL density results at 736 μs.

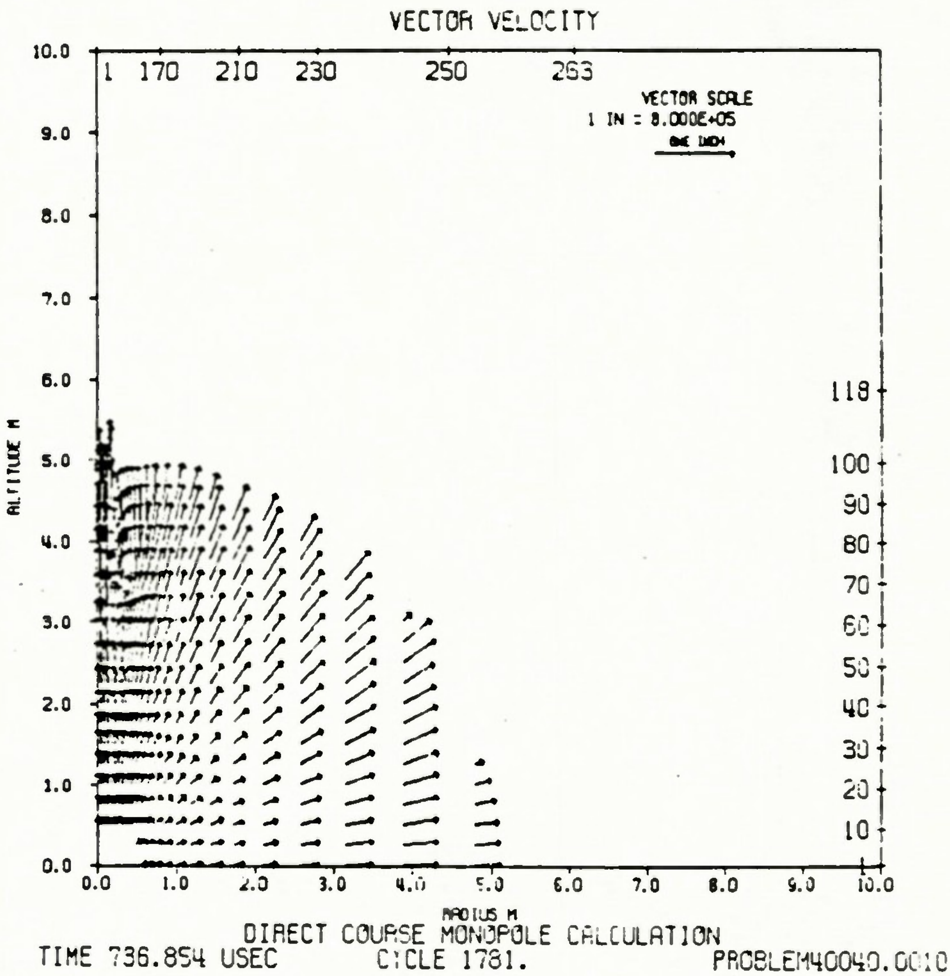


Figure 8. E-P HULL vector velocity results at 736 μs.

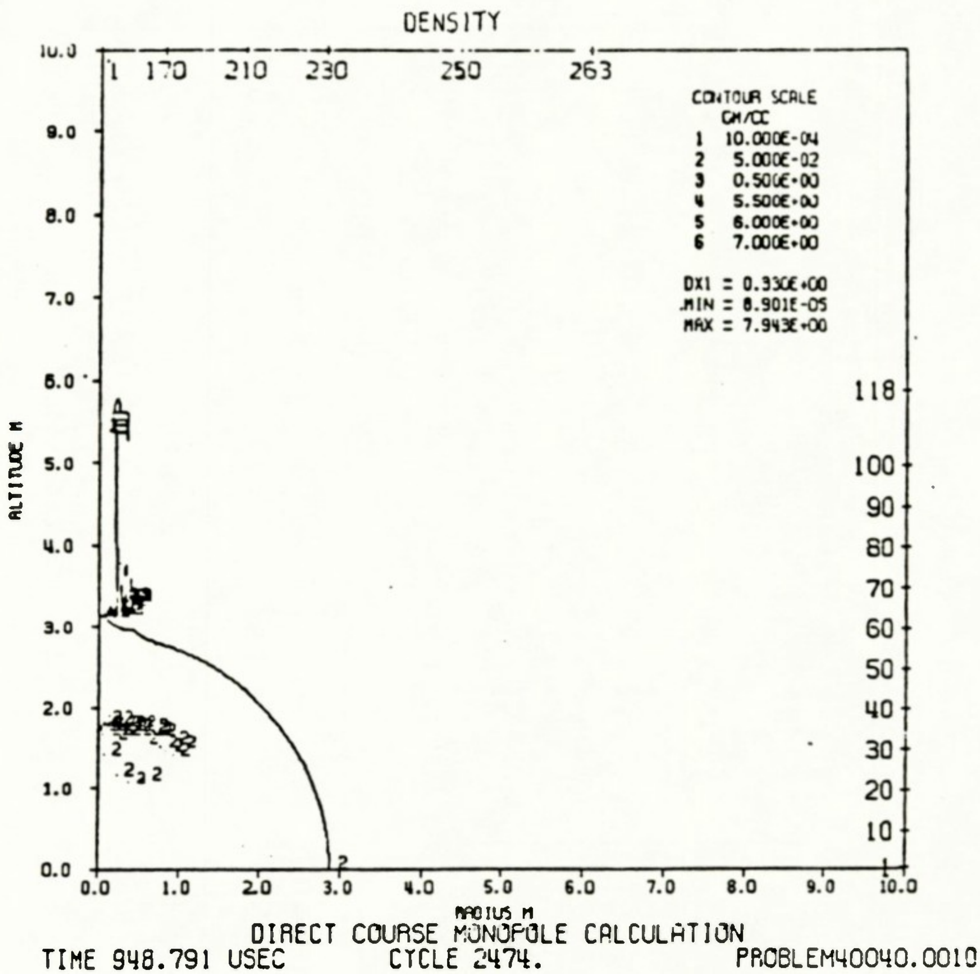


Figure 9. E-P HULL density results at 948 μs.

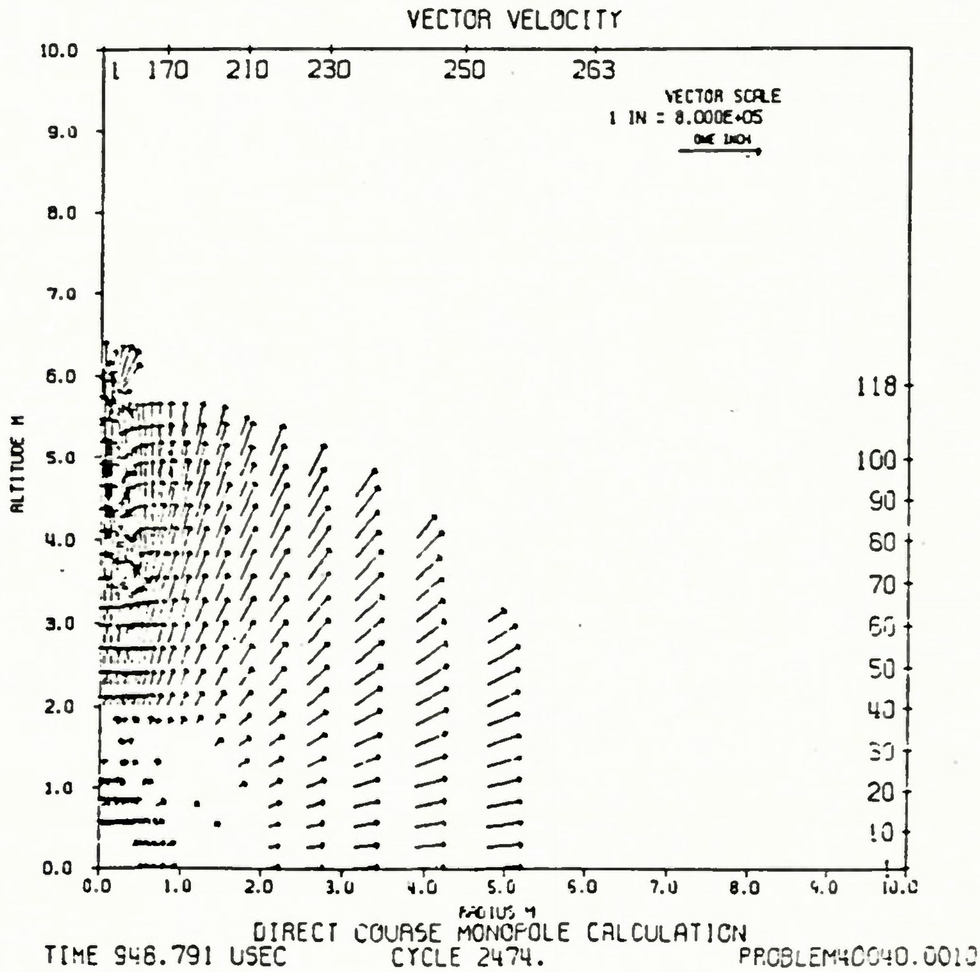


Figure 10. E-P HULL vector velocity results at 948 μs.

a radial velocity of 60.1 m/s (197.2 ft/s), an axial velocity of 61.9 m/s (203.1 ft/s), (or a speed of 86.3 m/s (283.2 ft/s)) directed upward from the vertical axis at an angle of 45.85 deg. Since the calculation can relate the transfer of energy from the environment to the target material, and does account for the strength properties of the target, some deformation is observed. However, the deformation at the end of this calculation indicates that the pipe is stretching radially, but has not broken. Information can not be gained about individual fragment geometries or masses. Another important concern is the time duration of the calculation. Due to the lack of computational time, the shock/fireball has not totally engulfed the upper support column. This, in turn, means that the total impulse associated with the event has not been imparted to the upper structure; therefore, the mass, velocity and angle data, previously mentioned, are preliminary. The data are for the material's parameters after the start of the loading process. In actuality these data represent a point along a dynamic curve which has not yet reached steady-state conditions (i.e., the upper steel column is still accelerating and deforming).

Conventional weaponry research has revealed information about initial conditions of bomb fragments. These conditions are deduced from measurements when certain constraints are placed on the test bomb. Usually the bomb is made up of highly controlled explosives and the geometry is cylindrical or spherical. The casing of the explosive is controlled by defining a desired geometry by scoring. Through high-speed photography and impact screens, fragment velocities and flight characteristics can be recorded. Knowing the aerodynamic characteristics of the known fragment, the initial velocity can be backed out. Knowing the initial velocity, the energy imparted to the fragment from the known explosive can be deduced. The energy transferred to the fragment is known as the Gurney energy constant, or the energy per unit mass of the explosive that can be converted into mechanical work (Ref. 5). Using the Gurney energy constant, bomb fragment distributions can be calculated. These distributions are most easily calculated using the work of Bishop (Ref. 6). The biggest problem is associating this type of fragment analysis with a low energy explosive such as ANFO. Another problem, when extending conventional weaponry work to this specific event, is the location of the fragment

material. In conventional weapons the metal material surrounds the explosive, however, in this effort the metal material is located almost one charge radius from the explosive surface.

In an attempt to relate known Gurney energy constants to explosives, it was found that, as suspected, the Chapman-Jougnet (C-J) pressure is directly related to the energy constants. Figure 11 shows a plot of 15 Gurney energy constants (Ref. 7) ($\sqrt{2E}$) versus C-J detonation pressures (Ref. 8). It was assumed that zero energy would produce zero C-J pressure and, therefore, a zero value of Gurney energy constant. Thus, a polynominal of the second order provided a close fit to these data. The form of the polynominal is as follows:

$$(\sqrt{2E} \times 10^2) = 2.20214 - 45.9372\ x - 5.43194\ x^2$$

where x = C-J pressure x 10^2 kbar.

Using the value of 61 kbar* as the C-J detonation pressure for ANFO a Gurney energy constant of 854 m/s (2.802 ft/s) can be calculated. This value, while not validated, will be assumed to be adaquate for the ANFO.

To summarize, S-CUBED calculated that the pipe will receive a free-field pressure on the order of 100 MPa. The Elastic-Plastic HULL calculation revealed that, at near 1 ms, the speed of the center of mass of the steel was 86.3 m/s. Finally, from conventional weaponry work, the Gurney energy constant is approximated as 854 m/s.

<u>Fragment Trajectories</u>--Many methods are available for trajectory analysis, most of which stem from aerodynamics. The simplest form of trajectory analysis is presented in Appendix A. This derivation of trajectory assumes that the drag force is small relative to the gravity force. This assumption is adequate for ballistic, streamlined objects but may not represent the fragments of concern in this effort. The range equation, derived from this analysis is as follows:

$$R_s = \frac{V_i^2}{g} \sin \Phi_i$$

*Private communication with C.E. Needham, S-CUBED, Albuquerque NM, February 1983.

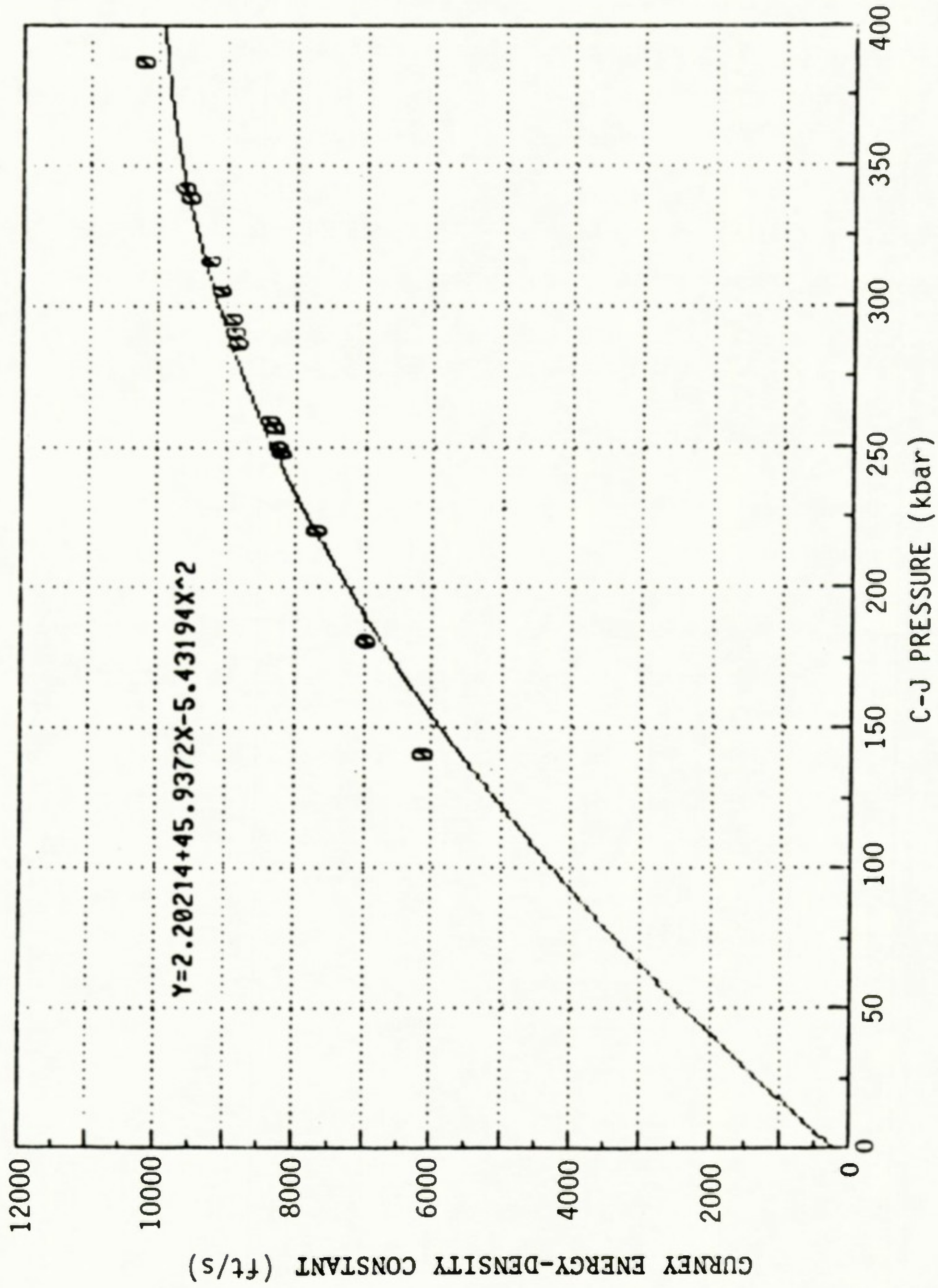


Figure 11. Gurney energy constants versus C-J pressures.

where

R_s = maximum range

V_i = initial velocity

g = acceleration due to gravity

Φ_i = initial angle of projection

The major downfall of this analysis is the assumption that the force due to drag is negligible relative to the force due to gravity. The flight of any fragment in Pre-DIRECT COURSE is relatively close to the surface of the earth so the density of air also becomes important. Since the drag coefficient is large (one or greater), it cannot be assumed that the fragment's drag coefficient is low (i.e., the fragment does not happen to be streamlined).

Detailed conventional weapon analysis, such as derived in Reference 6 assumes that drag is a major factor. This analysis accounts for fragment size and shape as well as the weight of the explosive. The fragment size (or thickness) is resolved to be the most important factor in determining the maximum fragment range. It is also stated in Reference 6 that the greatest possible fragment velocity occurs when the case weight is negligible compared to the explosive weight. In Pre-DIRECT COURSE the upper support column has a mass of approximately 453.6 kg. Thus, if it is assumed that this mass is evenly distributed around the exterior of the explosive, the case to the explosive weight ratio is 1/46 (a relatively small number compared to conventional weapons).

Bishop (Ref. 6) utilizes the aerodynamic drag as established by Hoerner for regular shapes in subsonic and supersonic velocities. Two distinct classes of shapes are considered. The first class is composed of regularly shaped projectiles with sharp pointed conical or wedge shaped noses. However, due to probability analysis it is unlikely that this would occur. Assume, though, that one fragment did possess these properties. Generally this fragment would not have its center of mass located to insure stable motion through the air with the sharp point or edge headed forward at all times. Bishop's second class of shapes are those that do not have the special characteristics of the first class. These fragments are characterized by a constant

coefficient of drag over a wide range of supersonic velocities. The coefficient of drag is always greater than one except for regularly shaped rounded bodies (i.e., spheres and cylinders) for all sub- and supersonic velocities. The coefficient remains as such at trans- and supersonic velocities due to the occurrence of a detached shock wave some distance in front of the projectile. The shock wave is detached for all fragments except those in the first class. In the first class the shock wave can be attached to the nose of the fragment only when the nose angle is less than ε, where $\varepsilon = 1/M$ and M = the Mach number. All other fragments are in the second class and have a detached shock wave.

Finally, consider the orientation of the fragment in flight. The general condition for approximately stable flight of a nonrotating fragment requires that the center of mass be well ahead of the line of action of the resultant aerodynamic drag force for at least a small range of fragment orientations in any direction from a zero-lift attitude. Otherwise the particular zero-lift attitude assumed is unstable, and the fragment tends to oscillate, or even tumble. A homogeneous nonrotating fragment having a uniform density and an unstable zero-lift orientation is usually reached when the fragment presents its minimum frontal projected area. This applies especially to a thin flat sheet of material (but not rotating).

A thin flat sheet is generally unstable when moving edge-on through the air, since the aerodynamic lift force (at any small angle of attack) acts with a torque couple about the center of mass--which tends to rotate the sheet into a position with a larger angle of attack. The larger angle of attack results in an increased torque, which tends to increase the angle of attack even further, etc. Thus, the leading-edge type of flight is an unstable zero-lift orientation.

The perpendicular type of zero-lift orientation is at least semistable; when a flat shape moves so that the maximum frontal area is presented, there is a range of the angle of inclination within which the resulting torques are of a restoring variety instead of an overturning variety. The restoring torque (approximately cosine) is small, which means that the flat shape may oscillate through a considerable angle before any appreciable restoring torque comes into play. Thus, the slightest air flow disturbance results in directional oscillations which do not damp out readily. When the fragment turns

completely over, instead of merely oscillating back and forth, a more complicated analysis is required. This analysis is presented in Reference 6 work and will not be repeated here.

It is stated in Reference 6: "One can be sure that the maximum dimensions of any fragment will be less than the radius of the container surrounding the explosive charge." However, when an explosive charge is not closely contained or when asymmetries exist, the fragment may be large, as in Pre-DIRECT COURSE. However, Bishop does not account for fragments considered in the specific case of the Pre-DIRECT COURSE. He does state that the edge and face area results in an aerodynamic factor that is "a statistical quantity that can only be found by observing a large number of fragments from many experiments".

Even though Gurney's and Bishop's analyses do not consider the specific case of Pre-DIRECT COURSE, ball park factors may be gained from this type of analysis. In the conventional exercises the majority of the explosive energy is directly imparted to the encasing metal. In Pre-DIRECT COURSE, the metal is almost one charge radius away from the explosive. When considering spherical divergence, it can be safely assumed, that less energy is imparted to the metal than if it surrounded the explosives.

A summary of the equations derived by Bishop are presented in Appendix B. This analysis will be used in predicting fragment trajectories for Pre-DIRECT COURSE. The values from this analysis are assumed to be liberal considering the aforementioned caveats.

Fragment Trajectory Calculations--Table 2 presents the presumed fragment initial conditions from the calculations and extrapolated Gurney analysis. These values represent the Gurney energy--density constants only and do not factor in the geometrical shape of the bomb. From Bishop's analysis, one realizes that as the ratio of explosive weight to case weight increases, the initial velocity of the fragments (as predicted by Gurney) approaches the value of $\sqrt{2E}$. Since Pre-DIRECT COURSE had a low weight ratio it can be assumed that the predicated and calculated values of $\sqrt{2E}$ are the initial velocities.

Utilizing these initial conditions the various ranges were calculated using the methods derived and explained in Appendices A and B. The results from these exercises are presented in Appendix C. To estimate fragment sizes,

TABLE 2. FRAGMENT INITIAL CONDITIONS

Method	Initial Velocity	Gurney-Energy Density Constant
S-CUBED Calculations	UNDEF	NA
Elastic-Plastic HULL Calculations	86.3 m/s at 1 ms	NA
C-J Pressure vs $\sqrt{2E}$ Analysis	854 m/s	2,802 ft/s

in the Bishop analysis case, random dimensions were chosen to try to bound the expected sizes. Figure 12 presents the fragment size versus calculated range for a given initial velocity. These values must be used with caution since, as previously stated, the simplified analysis is a known overestimation and Bishop's analysis is indirectly related to Pre-DIRECT COURSE.

Experimental Procedures--In an attempt to verify the theoretical calculations associated with this effort, high resolution photographic measurements are required. This coverage requires both ground and aerial platform-based coverage. The photography will consist of both 70 mm and 35 mm ground-based and 35 mm aerial photography. The cameras will have overlapping formats and record at speeds of 30 and 360 fr/s. Three ground-based camera stations will be used in an attempt to correlate one camera's images with another. The data from these cameras, if successful, will give tighter and more precise data than from any one camera. One problem with noncorrelated ground-based photography is the image plane of the camera. A camera will record anything in the field of view. This field includes any objects moving toward or 180 deg away from or anywhere in between. To precisely calculate fragment trajectories, the fragment must be on a plane perpendicular to the camera's head on viewing angle. If the fragment is traveling on any other course the cosine of the angle, relative to the perpendicular must be considered.

To solve this problem, two options become available. These are: (1) an increased quantity of ground-based cameras, or (2) aerial cameras which provide another plane of the three-dimensional geometry. Therefore, driven by a cost analysis basis it would be advantageous to utilize aerial photography.

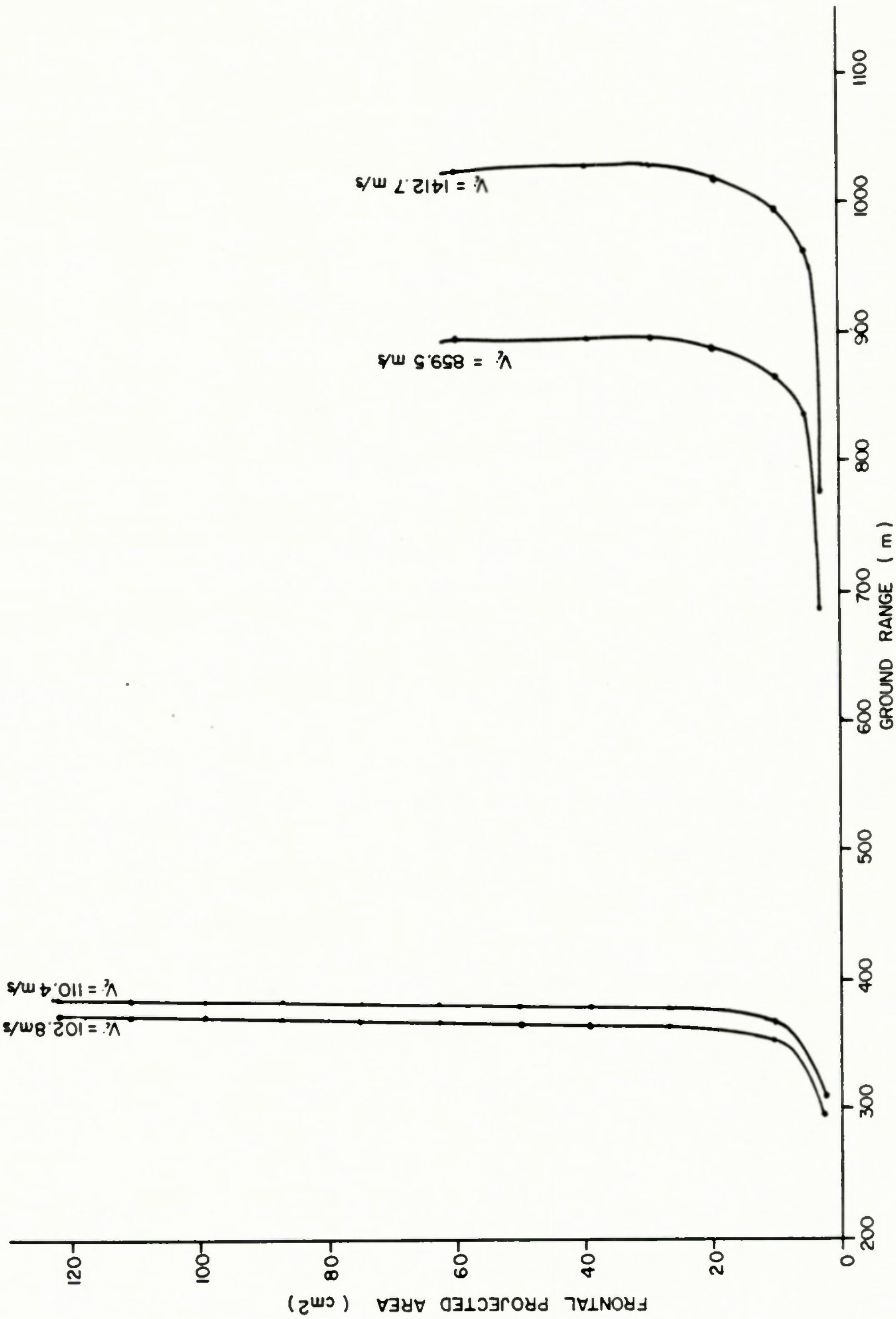


Figure 12. Fragment size versus ground range.

In addition to the dynamic photography, two additional validation techniques are to be utilized. The first is aerial photography. This photography would be low level, high resolution ground mapping of the surface. Pretest aerial photography will be taken of the test bed area out to 609.5 m radius from ground zero. Posttest photography will repeat this documentation. Any differences in pre- and posttest documentation will be recorded and be investigated. The second validation technique is a rigorous ground search. This ground search will consist of an extensive walk search for fragments from ground zero out to ranges of 609.5 m. Once the fragments are tagged, another team will survey and record the specific fragment data.

The coupling of these measurement techniques is vital to verifying the predictive methodologies. If any portion of the technique is omitted much more analysis is required and will not yield as accurate results.

Structural Identification--To identify the fragments during the posttest recovery, several steps were taken to uniquely mark various pieces. The top 26 channels of the battened column were indented, by metal stamping, with a letter of the alphabet. The letter A was on the top rung, progressing down, rung by rung to the letter Z. In addition to the letter, each side was stamped with a number (1 through 4). The sequence of number and letter was stamped several times on each channel, in anticipation that the channel would break. This method of identification covered each side of the battened column for more than 50 percent of the length of the entire column.

The upper steel column was also marked. The pipe was also metal stamped using the aforementioned procedure. The letter A started at the bottom of the pipe (next to the attachment to the fiberglass column) and extended by 10.16 cm increments, to the letter Y. The numbers 1 through 4 were again used with the letters to form four separate vertical lines (90 deg apart) of identification over the entire length of the pipe. In addition to the markings, the upper support column and attachment were painted fire engine red.

The numbered vertical lines on the upper support column and the numbered sides of the battened column were lined up. The number 1 line was oriented toward 33 deg (test bed coordinates), number 2 toward 123 deg, number 3 toward 213 deg, and number 4 toward 303 deg.

Jet Retardation--Sufficient concern was generated over the shock-tube effect that a jet retardation scheme was designed. The goal was to create a baffle inside the upper portion of the fiberglass column and the upper support column which would control a jet and allow the exterior of the pipe to be loaded first. If the jet could be controlled, the upper pipe would, theoretically, be put into compression and possibly not fragment to a large degree.

Figure 13 shows the scheme designed for Pre-DIRECT COURSE. The system is composed of polystyrene, plywood disks, and sand-filled bags. The plywood disks are located just above the holes in the fiberglass column. The polystyrene disks are used as spacers. The attempt is to retard the jet enough to fracture the fiberglass column near the area of the holes. In this manner,

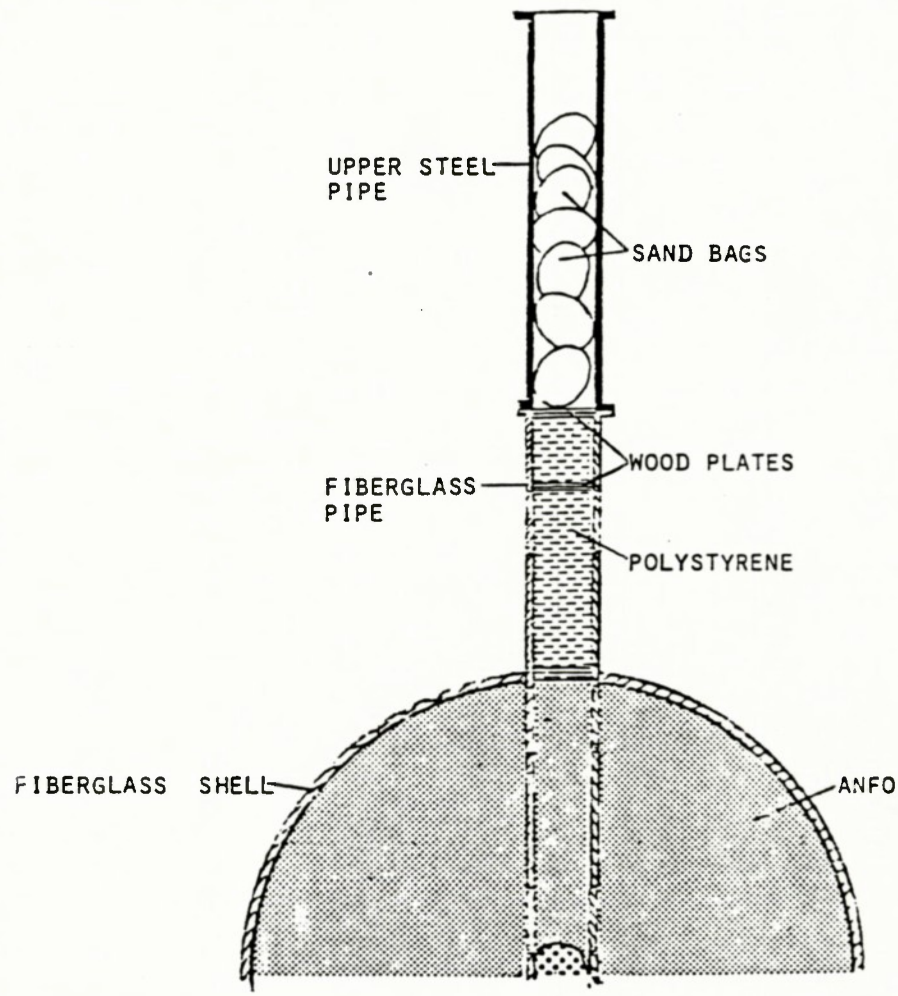


Figure 13. Jet retardation system.

the jet may be damped out prior to reaching the steel member. The purpose of the sand bags is to essentially provide more mass than ambient air and possibly delay any pressure gradient between interior and exterior loading on the pipe. This scheme, although primitive, was the most acceptable due to time and cost limitations.

Trajectory Control--The fragment prediction analysis indicated that some of the upper support column would not be fragmented. The possibility of controlling the trajectory of the remaining column was considered. The New Mexico Engineering Research Institute (NMERI) designed a simple, low cost guidance system. Briefly, cables are attached at one end to the upper support column and the other end is attached to a large concrete block. The block is on rollers which are on a small concrete slab.

As the upper support column moves, the cables become taut and pull the concrete block. In a short time the concrete block will roll off the slab and jerk the cables. This sudden stop will pull on the upper support column and initially direct it toward the concrete block.

III. RESULTS

Posttest Overview---The test site was recovered immediately after the detonation. From a distance, a large portion of the lower battened column appeared to be standing, but was bent and twisted. Upon closer examination it was noted that the top portion of the column extended to 8.2 m (26.9 ft) above the ground surface. An even closer examination revealed that only approximately 1.5 m (4.92 ft) of the column was left standing (Fig. 14). This photograph shows that the column was sheared off at the four uprights approximately 1.5 m above the ground surface. The upper 8.2 m of the column was driven down and wedged into the bottom 1.5 m (Fig. 15). Thus, the majority of the battened column just happened to be standing.

Figure 16 shows the top remaining portion of the battened column. Note that the channels were stripped off of the angle iron legs. The letter guide system indicated that the channels lettered L remained. This indicates that eleven levels of channel were stripped off the column. Also note that some of the angle iron legs are missing. The points of failure of the channels and angle iron appeared to be at locations of welds. The welds held but the material fractured at the high local stress locations.

Figure 17 shows a close-up of the middle portion of the battened column. A distinctive bend is noted. Correlation back to pretest conditions indicates that this is the location of the polystyrene block. Apparently as the shock/fireball was traveling down the column the polystyrene acted as a temporary blockage stagnating the flow and causing a high reflected pressure which deformed the column.

The typical fragments of concern in this study are shown in Figures 18 and 19. Figure 18 shows a piece of channel of approximately 105 cm^2 (16.28 in^2). The final location of this fragment was 97.5 m (319.9 ft) from ground zero. Figure 19 shows a larger fragment (the dark object in the lower left corner). This fragment was approximately 310 cm^2 (48.05 in^2). It is readily apparent that some damage could have easily occurred to the gage mounts in the background.

Fiqure 14. Remaining structure overview.

Figure 15. Close-up of bottom of structure.

Figure 16. Close-up of top of structure.

Figure 17. Close-up of middle of structure.

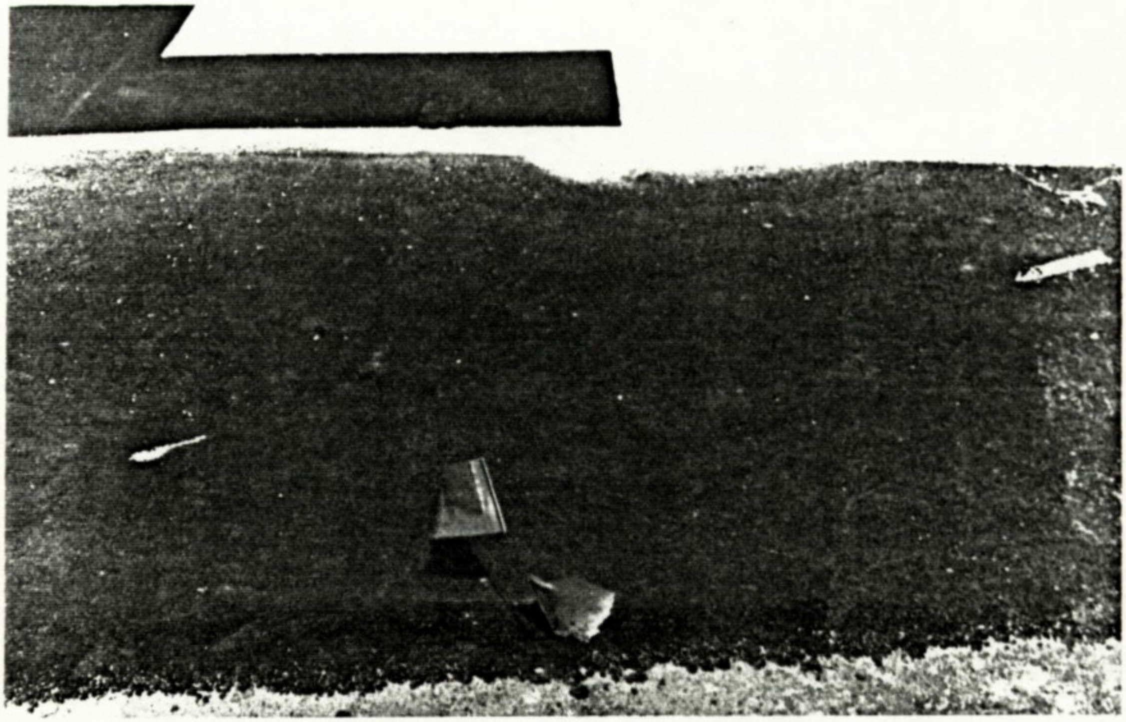


Figure 18. Typical small fragment.

Figure 19. Typical large fragments.

Figures 20 and 21 show the damage inflicted upon the hardened concrete radials. The concrete was pulverized from the direct impacts and scattered over the area. Figure 22 displays the metal which was removed from the hole shown in the center of the photograph. Apparently the lower column acted as a funnel for some period of time and allowed the fragments to drive themselves into the concrete. The final fragment was found 80 cm (2.625 ft) below the concrete surface. The total mass of the metal found in the hole was 36.3 kg.

The major portion of the upper steel column is shown in Figure 23. Approximately 60 percent of the original column is shown. This portion was found on the 323 deg azimuth, 22 m (72.2 ft) from ground zero. One can easily detect that the column was peeled back until shear occurred.

Photographic Analysis--The experimental photographic information provided adequate data. The ground-based photography was analyzed by the Physical Sciences Laboratory (PSL). The PSL found that the 35 mm photography covered too wide of a range and could not provide sufficient resolution to track fragments of interests. The 70 mm photography, although limited in field of view, provided enough resolution to track a fragment of 85 cm^2 (13.2 in^2). From the three 70 mm cameras, 92 fragments were tracked. The results from this analysis are presented in Appendix D. These data reflect calculated fragment position-time data, as well as predicted velocities and suspected trajectory angles. Table 3 presents a summary of the ground-based photographic data. Listed in this table is the apparent area of the fragment, the flight profile, and the average velocity. The minimum and maximum values from this table are: apparent area: min—0.0085 m^2 (0.0915 ft^2), max—0.4949 m^2 (5.33 ft^2), average velocity: min—32 m/s (105 ft/s), max—629 m/s (2064 ft/s). Also, the majority of the observed fragments appeared to have been tumbling during their trajectories.

Figures 24 through 26 depict the individual fragment trajectories as viewed from the three camera stations. Note that a large circular area around the depicted charge is void of any fragments. This area is not empty in the actual photography, but is obscured by the fireball and debris. The first time any fragment is observed is 61 ms after time zero. This supports the

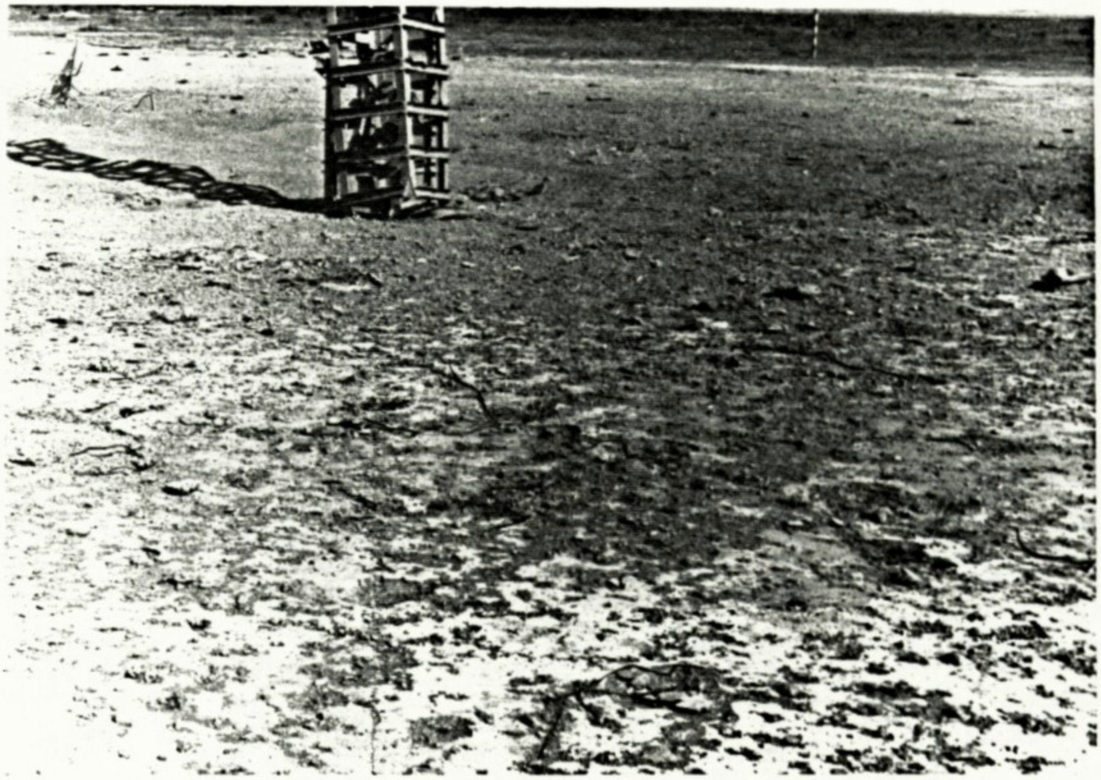


Figure 20. Concrete radial, posttest (Close-in).

Figure 21. Concrete radial, posttest (Far-out).

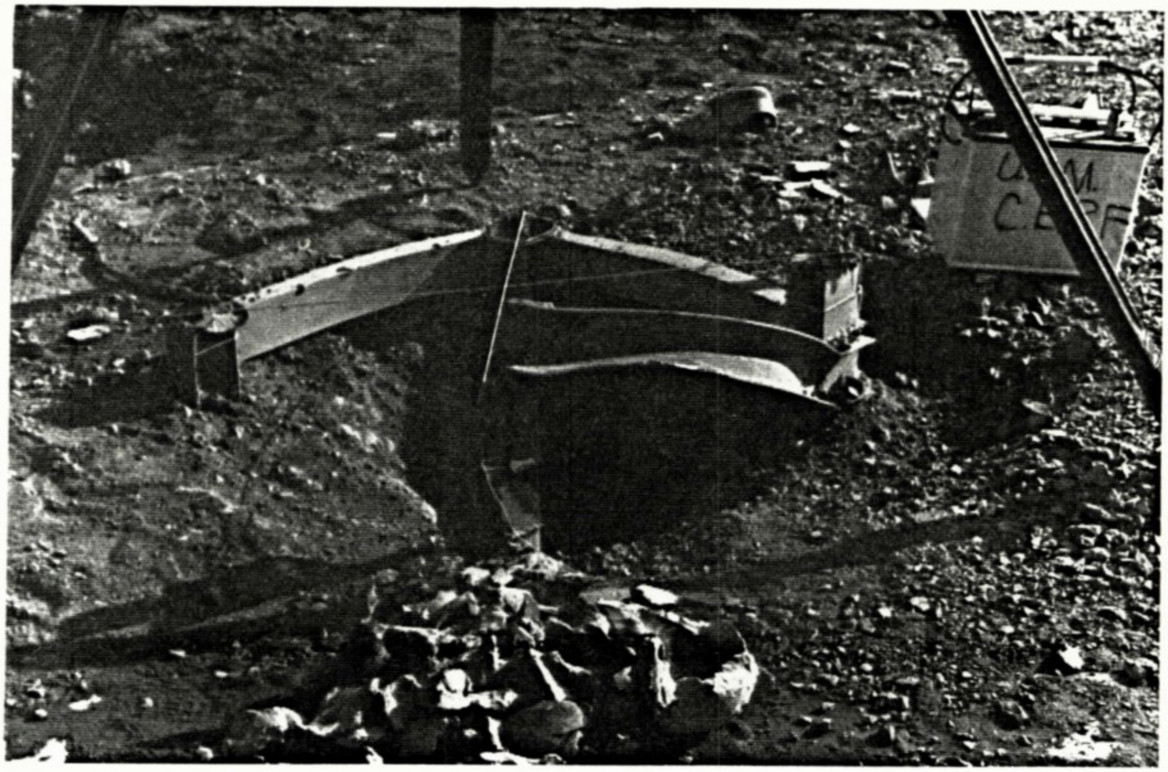


Figure 22. Metal recovered at ground zero.

Figure 23. Posttest view of upper steel column.

TABLE 3. GROUND-BASED PHOTOGRAPHIC DATA

FRAGMENT	APPARENT AREA (M^2)	FLIGHT PROFILE	AVERAGE VELOCITY (m/s)
1	0.1295	STAB	560
2	0.1403	STAB	629
3	0.1040	TUMB	474
4	0.1365	TUMB	381
5	0.0350	TUMB	164
6	0.0242	TUMB	359
7	0.0826	TUMB	590
8	0.0784	TUMB	382
9	0.0918	STAB	448
10	0.0252	STAB	371
11	0.1062	ROTA	423
12	0.1566	STAB	337
13	0.1113	TUMB	448
14	0.0085	TUMB	346
15	0.1056	STAB	276
16	0.1281	ROTA	402
17	0.1804	STAB	307
18	0.0656	STAB	279
19	0.0518	TUMB	281
20	0.1344	TUMB	172
21	0.0900		88
22	0.0942	TUMB	138
23	0.0848	TUMB	62
24	0.1176	TUMB	152
25	0.0812	STAB	74
26	0.1825	TUMB	144
27	0.1020	ROTA	99
28	0.0384	TUMB	107
29	0.1030	TUMB	173
30	0.1692	TUMB	194
31	0.0768	TUMB	108
32	0.0468	TUMB	115
33	0.0630	ROTA	125
34	0.0330	ROTA	117
35	0.1219	ROTA	65
36	0.1178	ROTA	110
37	0.1320	TUMB	74
38	0.0344	TUMB	87
39	0.0504	TUMB	95
40	0.1197	TUMB	73
41	0.1176	STAB	71
42	0.0858	ROTA	51
43	0.1512	TUMB	510
44	0.0360	TUMB	359
45	0.0288	TUMB	347
46	0.0784	TUMB	279
47	0.1311	TUMB	393
48	0.1008	TUMB	379
49	0.1460	TUMB	322
50	0.0988		354

TABLE 3. CONCLUDED

FRAGMENT	APPARENT AREA (M^2)	FLIGHT PROFILE	AVERAGE VELOCITY(m/s)
51	0.1080		
52	0.1380	TUMB	426
53	0.0969	TUMB	466
54	0.2574	TUMB	308
55	0.1885	TUMB	340
56	0.0644		308
57	0.0826	TUMB	231
58	0.0812	TUMB	288
59	0.1296		419
60	0.0954	TUMB	199
61	0.2668	TUMB	262
62	0.1290		260
63	0.2580	TUMB	138
64	0.2208	TUMB	116
65	0.1311		99
66	0.2296		70
67	0.4797	TUMB	144
68	0.4949	TUMB	80
69	0.2712	TUMB	94
70	0.0841	TUMB	629
71	0.0840	TUMB	435
72	0.0896	TUMB	330
73	0.1120	TUMB	333
74	0.1914	TUMB	327
75	0.0858	TUMB	336
76	0.1848		297
77	0.1521		187
78	0.1890		165
79	0.0378	TUMB	158
80	0.1024		269
81	0.1148	STAB	134
82	0.3040	ROTA	116
83	0.1449	TUMB	165
84	0.1104	TUMB	66
85	0.0594	TUMB	58
86	0.3562	TUMB	48
87	0.0828		75
88	0.0480		38
89	0.0574		34
90	0.2511	TUMB	54
91	0.2635	TUMB	32
92	0.2988	TUMB	33
			88

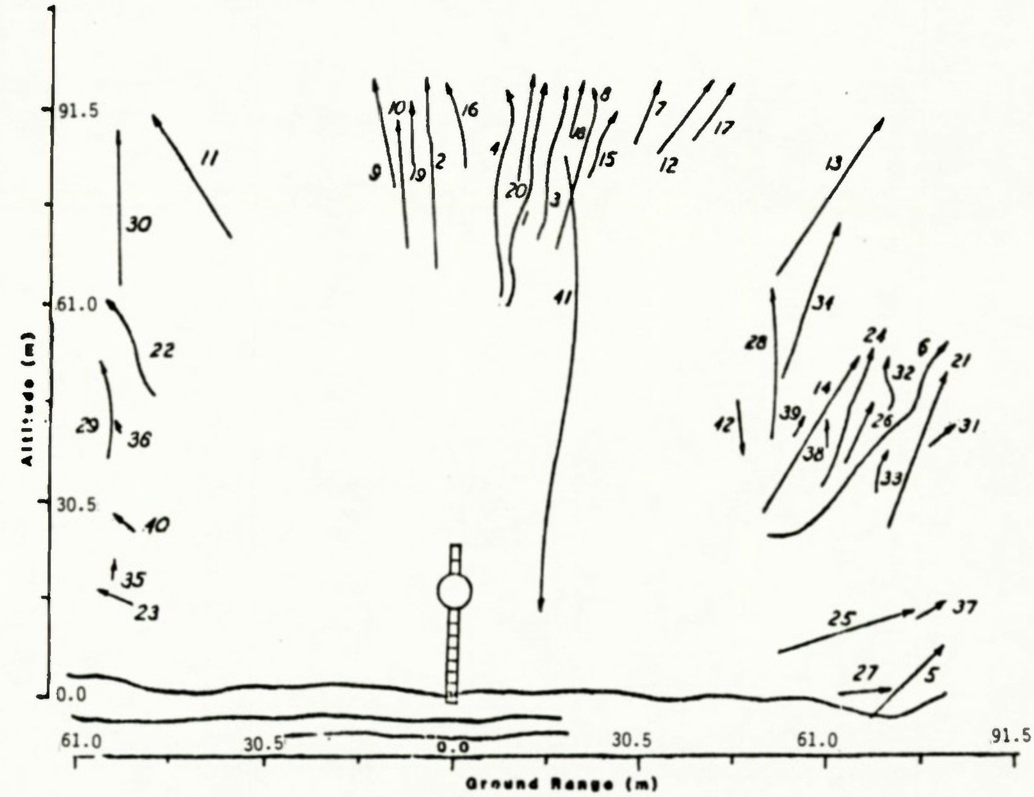


Figure 24. Fragment trajectories from camera F3386.

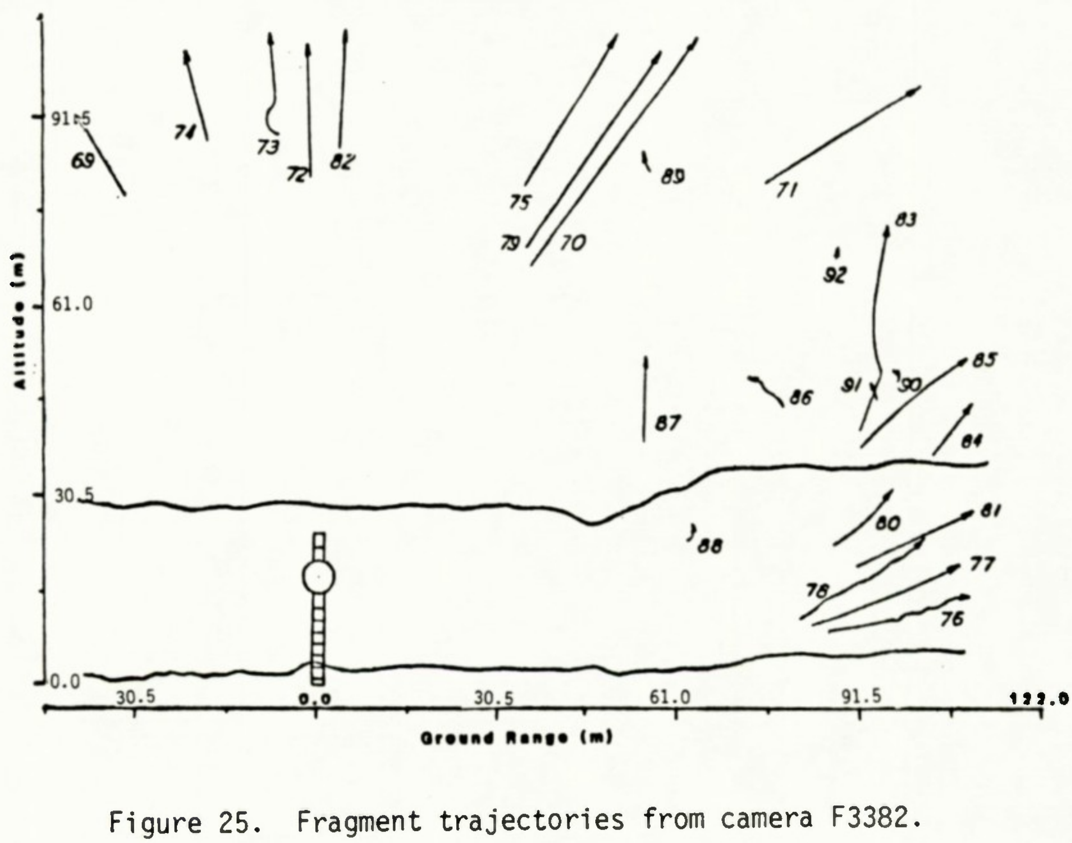


Figure 25. Fragment trajectories from camera F3382.

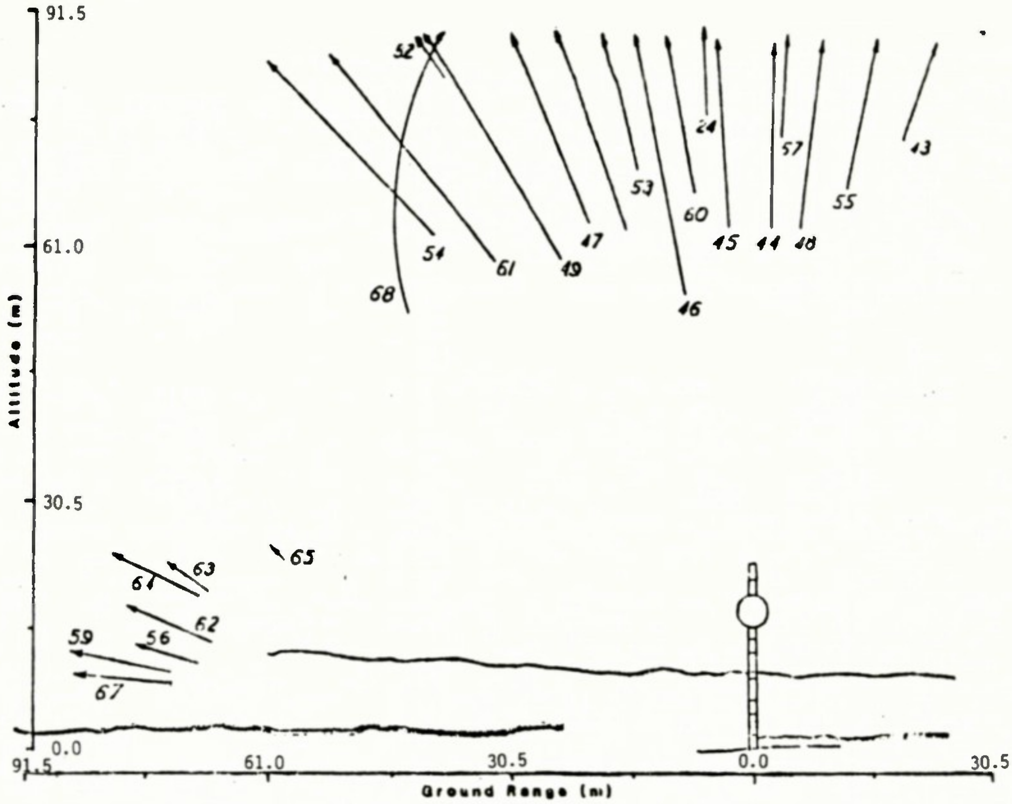


Figure 26. Fragment trajectories from camera F3365.

belief that the metal does not begin to break up and move until after a substantial loading takes place. Additionally, at this specific time, the fragment is first observed at a distance approximately two HOBs away from the charge. The last time any fragment is seen moving vertically is at 422 ms. Other fragment motion is recorded, but these fragments have either reached their apogee and are returning downward or are moving more horizontally than vertically. The limit to any tracking, as shown in the sketches, is bounded by the field of view of camera and lens.

Another attempt was made to use the ground-based photographic data for a more precise analysis. The data from the three cameras were combined in an attempt to triangulate fragment trajectories. This method was successful, but for very few fragments. These data are accurate, but have a large scatter (this indicates the extremely large scatter in the data using one camera). The data from the triangulated analysis are presented in Appendix E. Thirteen fragments were commonly observed by two or more cameras.

Table 4 presents a summary of the trianglulated data. Of the 25 fragments triangulated the minimum fragment size was 0.0252 m^2 (0.2713 ft^2) and the maximum size was 0.4949 m^2 (5.33 ft^2) and a mean of 0.1271 m^2 (1.37 ft^2). The minimum and maximum velocities were 53 and 1638 m/s (174 and 5374 ft/s), respectively and a mean of 491.13 m/s (1611.4 ft/s).

The ground-based photography did provide useful information, but the errors associated with the data are large. Because of the masking and dimensions of the fireball and debris, fragments could not be tracked from their points of origin. Single camera coverage is not adequate enough to define the flight trajectory of any fragment. Multiple camera coverage provides more accurate flight trajectories, however, it is difficult to correlate one specific fragment from one camera to other cameras. Also, when using multiple or a single camera, it is uncertain if that fragment trajectory is in one plane.

In an attempt to validate the theoretical predictions, the photographic data present some values provided the assumptions are valid. Using the time and position data of the center top object from the triangulated data a deceleration rate can be deduced. For simplicity, and lack of substantiating data, assume that the deceleration is linear; also, assuming that the movement of the fragment is primarily in the Z-direction, and horizontal motion is negligible. Extrapolating the measured data back to a time of zero and subtracting the calculated deceleration from the measured velocity it is found that the estimated initial velocity is 878 m/s. This value is near the extrapolated information from the Gurney data. It is important to realize that any fragment could be used to estimate the initial velocity, and different values would be deduced. However, this fragment was chosen because of its nearly vertical trajectory and likelihood of high quality data from the triangulation analysis.

A further analysis could entail extrapolation of the fragment back to its original location and outward to impact points. Additional correlation could also be attempted connecting this data to the fragments found during the ground search. At present the data from the aerial photography are not available for correlation and analysis.

TABLE 4. TRANGULATED PHOTOGRAPHIC DATA

FRAGMENT	APPARENT AREA (M^2)	AVERAGE VELOCITY (m/s)
1	0.1512	572
2	0.0360	402
3	0.0288	369
4	0.1311	420
5	0.1008	315
6	0.0954	361
7	0.2712	
8	0.1104	53
9	0.2296	152
10	0.0826	314
11	a	1638
12	0.4949	572
13	0.1062	402
14	0.0252	369
15	0.0784	420
16	0.1062	315
17	0.1113	361
18	0.1403	
19	0.0344	53
20	0.1499	152
21	0.1120	314
22	a	1638
23	0.1344	152
24	0.0656	314
25	a	1638

a Undefined area

Ground Search Analysis--Immediately after the Pre-DIRECT COURSE event an extensive ground search was initiated. The search started at ground zero and extended out to 609 m, and consisted of several men walking various radials, tagging fragments. It was fairly extensive and consisted of approximately 60 manhours. After the physical ground search failed to yield many fragments per manhour, the survey process began. Measurements of angle and range from ground zero were recorded within an accuracy of 0.305 m (1 ft) in range and 1 deg of angle.

This search resulted in 161 fragment recoveries. The data included the remaining portion of the upper steel column to nuts from guy cable attachments. The specific number of types of fragments is listed below:

Number	Description
31	Angle
47	Channel
51	Metal Plate (could be undefinable channel or angle)
11	Cable
13	Miscellaneous (rings, nuts, etc)
8	Definite portion of upper steel column

The fragments ranged from ground zero out to 518 m (1700 ft). A detailed listing of the fragments recovered is presented in Appendix F. An important consideration is that all fragments were not recovered. Many were believed to be buried in the ground, especially on the dusty radial. Also, approximately only 85 percent of the total mass of the upper steel column was recovered. The missing 15 percent of the column could have been fragmented and recovered but not recognized, or simply never found.

Figure 27 shows a plan view of the fragment locations. A close examination shows that a preferential scattering took place. Four areas on the figure show a lower distribution than the remaining areas. These areas are 45 deg, 135 deg, 225 deg and 315 deg. Review of the initial test conditions reveals that these angles roughly correspond to the location of the legs of the lower battened column.

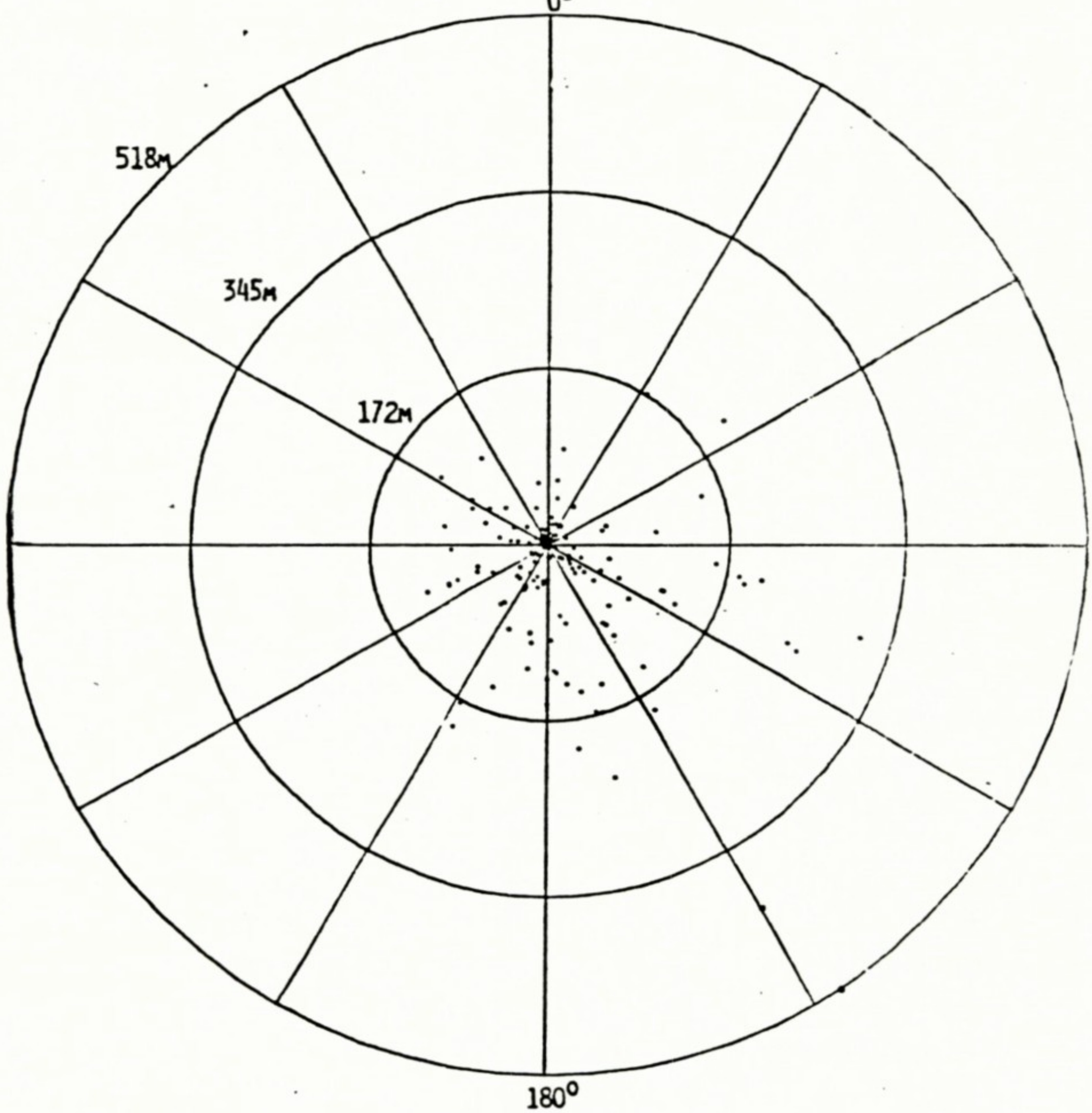


Figure 27. Plan view of fragment impacts.

The range distribution of fragments was also calculated via a Gaussian density. The results are shown in Figure 28. The mean distance of fragment location was 68.4 m (224 ft) from ground zero with a standard deviation of 11.3 m (37.1 ft).

Probability of Impact--Probabilities of impact must be decided to determine if hazards to personnel or experiments exist from fragments. As stated previously, 161 fragments were recovered from the ground search. Assuming that the search only revealed one-half of all the fragments, the total count would be 322. By dividing the test bed area into circles one can determine how many fragments landed in each circle (using the factor of safety of 2, a conservative estimate should be formulated). From the previous section a scaled Gaussian density plot provides a probability of occurrence at any one location based on all of the data.

Table 5 presents the area data and probabilities of a fragment impacting in that area. The first column is the radius of the area of concern. The second column presents the normalized Gaussian density from Figure 28. The next column presents the areas from the radii of column 1 ($A = \pi(r_o^2 - r_i^2)$). The fourth column shows the probability of a fragment impacting in the area presented in the third column. The final column presents the probability of a fragment impacting in the corresponding areas assuming the ground search was only one-half complete. According to this type of analysis the highest probability of impact is between the 60.9 and 121.9 m (200 and 400 ft) ground range. Note that this analysis considers the number of fragments which land in the areas and not the probability of one fragment landing in the area.

If the potential for a fragment impacting upon a certain object is considered, a further step is required. Knowing the object area, this can be used as the numerator, with the probability from the right column of Table 5 as the denominator, to calculate the probability of impact upon the object. As an example consider the human fragment impact hazard. As a general guideline the safety criteria for an individual susceptible to a lethal fragment is defined as a material possessing an impact energy of 78.6 J or greater. An individual is considered to occupy 0.56 m^2 (6.03 ft^2). Therefore, not more than one lethal fragment may be delivered per 5.57 x 10^5 m^2 (6.0 x 10^6 ft^2). Table 6 presents the probability of a 0.56 m^2 area being struck by a lethal fragment.

*Oppedahl, P. E., Ltr to White Sands Missile Range (STEWS-NR-P), N Mex, Sep 1982.

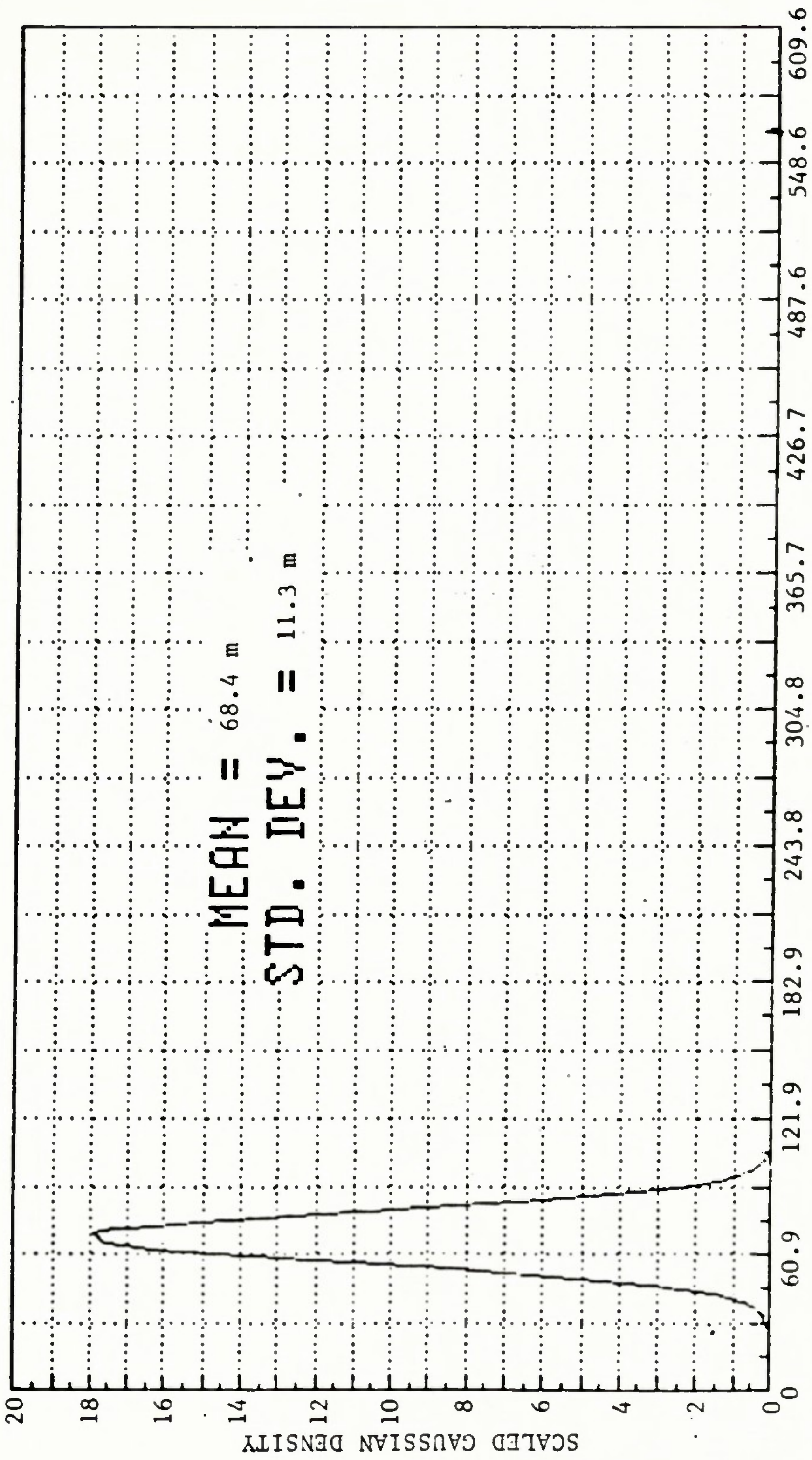


Figure 28. Gaussian density fragment distribution.

TABLE 5. PROBABILITY OF FRAGMENT IMPACTS

RANGE (m)	GAUSSIAN DENSITY	AREA (m^2)	AREA PROBABILITY	CONSERVATIVE IMPACT PROBABILITY
0 - 7.6	1.06088×10^{-4}	182.4	3.1739×10^{-7}	6.347×10^{-7}
7.6 - 15.2	2.08206×10^{-3}	547.2	6.2290×10^{-6}	1.246×10^{-5}
15.2 - 22.8	0.04456×10^{0}	912.0	1.3333×10^{-4}	2.667×10^{-4}
22.8 - 30.5	0.34316×10^{0}	1276.8	1.0266×10^{-3}	2.053×10^{-3}
30.5 - 60.9	1.37513×10^{2}	8755.6	4.1140×10^{-1}	8.228×10^{-1}
60.9 - 121.9	1.96346×10^{2}	35022.5	5.8740×10^{-1}	1.175×10^{0}
121.9 - 182.9	2.75830×10^{-4}	58370.8	8.2520×10^{-7}	1.650×10^{-6}
182.9 - 243.8	2.19529×10^{-24}	81719.1	6.5670×10^{-27}	1.313×10^{-26}
243.8 - 304.8	7.36437×10^{-31}	105067.4	2.2032×10^{-33}	4.406×10^{-33}
304.8 - 1828.7	1.37231×10^{-42}	10214888.5	4.1056×10^{-45}	8.211×10^{-45}

TABLE 6. PROBABILITY OF HUMAN HAZARDS

RANGE (m)	PROBABILITY OF AN INDIVIDUAL IN PARTICULAR RANGE BEING STRUCK
0 - 7.6	1.9395×10^{-9}
7.6 - 15.2	1.2689×10^{-8}
15.2 - 22.8	1.6293×10^{-7}
22.8 - 30.5	8.9634×10^{-7}
30.5 - 60.9	5.2380×10^{-5}
60.9 - 121.9	1.8690×10^{-5}
121.9 - 182.9	1.5750×10^{-11}
182.9 - 243.8	8.9590×10^{-32}
243.8 - 304.8	2.3377×10^{-32}
304.8 - 1828.7	4.4806×10^{-52}

Scaling For Direct Course--The simple scaling from Pre-DIRECT COURSE (2.177×10^4 kg) to DIRECT COURSE, (5.445×10^5 kg) can be derived by Hopkinson or cube root scaling. This implies that distances, times, and impulses are scaled by the cube root of the ratio of the energies (yield). Thus the cube root scaling factor going from Pre-DIRECT COURSE scale to DIRECT COURSE scale is 2.924.

The scaling factor derived above is valid for scaling any hydrodynamic variables (p, t, and I). However, it is not appropriate for scaling stresses and strains. These quantities follow more of a square root scaling rule. Therefore, stresses in the steel members will be higher for DIRECT COURSE (five times).

Even though the stresses are higher in DIRECT COURSE, the dimensions of the members are scaled by the cube root. Therefore, the masses are also scaled. The major differences in the two structures will be along welded joints. At these locations, depending upon the design criteria, the welds could be actually stronger than the steel members. Thus, various forms of fragmentation may take place.

If we look at the basic displacement equation

$$s = \frac{1}{2} at^2 + V_0 t$$

where s = maximum distance traveled, a = acceleration, and t = time. Applying the boundary condition that at t = 0, $V_0 = 0$ we obtain

$$s = \frac{1}{2} at^2$$

However, the acceleration of a fragment is universally proportional to the fragment thickness.* The fragment thickness is proportional to the cube root of the charge weights, as is the time. Therefore, the terms cancel with each other and we obtain a scale factor of 1, which indicates that the velocities at the end of the acceleration phase should be identical for Pre-DIRECT COURSE and DIRECT COURSE.

However, since the fragment thickness is proportional to the cube root of the charge weight we again derive the scale factor of 2.924. (Since the dimension of steel thickness were scaled from Pre-DIRECT COURSE to DIRECT COURSE by a factor of 2.924.) Therefore, the ultimate scaling factor for deriving fragment distances for DIRECT COURSE should use the Pre-DIRECT COURSE data multiplied by 2.924.

*Ganong, G. E., (FCDNA/FCTOH), Personal Notes, 31 May 83

IV. CONCLUSIONS

Fragment prediction and analysis is unpredictable and almost impossible given one test. The best source of data is repetitive testing with large amounts of information. However, using various technologies and sources of information, data may be obtained which are sufficient for rules of thumb analysis. Quality photographic data are useful but may be too advanced considering the state of the art of fragment predictions. Simple trajectory analysis does not consider the drag force which plays a major role in fragment trajectories. More in-depth analysis, such as Reference 6, provides more accurate results even when extrapolated. No data exist, at close ranges, which will substantiate the assumed initial conditions. If such data did exist a more valid assessment could be assumed.

Notwithstanding these limitations, enough data were obtained from Pre-DIRECT COURSE to give a factor of confidence for DIRECT COURSE as currently envisioned. Simply stated, if a person is not within a 121.9 m radius from ground zero, that person would have a probability of less than 1 in 63 billion of being hit by a lethal fragment.

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APPENDIX A

This appendix presents a simplified approach to the trajectory of a fragment. The assumptions used are important. Although this report is not based on this particular analysis, it is presented because of its common occurrence.

SIMPLE TRAJECTORY ANALYSIS

For a simplified approach to trajectory analysis turn to the equations of motion based on a formulation of Newton's second law of motion.

$$\sum \overline{F}_{EXTERNAL} = m\overline{a}$$

since

$$\overline{a} = \frac{d\overline{v}}{dt} = \dot{\overline{v}}$$

$$\overline{v} = \frac{d\overline{r}}{dt} = \dot{\overline{r}}$$

$$\overline{a} = \ddot{\overline{r}}$$

so

$$\sum \overline{F}_{EXTERNAL} = m\ddot{\overline{r}}$$

Now determine the forces which act on the fragment. The net force will be a combination of aerodynamic forces, gravitational attractions, and miscellaneous effects due to electromagnetic fields, thermal radiation, etc.

Mathematically:

$$\sum \overline{F}_{EXTERNAL} = m\ddot{\overline{r}} = \overline{F}_{lift} + \overline{F}_{drag} + \overline{F}_{thrust} + \overline{F}_{gravity} + \overline{F}_{other}$$

Now applying the following assumptions:

$\overline{F}_{other}$ the net effect of miscellaneous forces, is so small compared to the other effects that it can be ignored without changing the accuracy of the solution.

$\overline{F}_{lift} = 0$ Since the fragments are assumed to have an average angle of attack of zero.

$\overline{F}_{gravity}$ the only noticeable gravitational effect is due to the attraction of the earth.

$(\overline{F}_{gravity} = m\overline{g} = \text{constant} \quad \text{where,} \quad \overline{g} = 9.807 \text{ m/s}^2)$

$\overline{F}_{thrust} = 0$ the fragment has no power and cannot accelerate.

$F_{drag} = 1/2\, \rho\, C_D\, A\, V_a^2\, \{\overline{V}_a/V_a\}$

where,

ρ = atmospheric density

C_D = coefficient of drag

A = fragment cross-sectional area as viewed from along the flight path

V_a = fragment speed with respect to the air mass

$\{\overline{V}_a/V_a\}$ = a unit vector along the instantaneous flight path. Drag acts opposite to this

If the fragment is unstable (tumbles or rolls) A and C_D are variables, and F_{drag} changes randomly.

Wind is not a force. It is an effect which appears in the drag term (specifically, V_a).

At this point the equation of motion is:

$$m\ddot{\overline{r}} = mg - \frac{1}{2}\rho\, C_D\, A\, V_a^2 \left\{\frac{\overline{V}_a}{V_a}\right\}$$

This is a second order, nonlinear, vector differential equation. This equation cannot be solved in closed form and needs further simplification.

Assume that drag is a small quantity compared to gravity (low C_D and A). This leaves one term in the vector equation of motion.

$$m\ddot{\overline{r}} = m\overline{g} \text{ or } \ddot{\overline{r}} = \overline{g}$$

This equation states that the acceleration on the fragment is due only to the effect of gravity. However, it does not tell the position and corresponding velocity at points along the trajectory. The equation must be integrated to produce equations giving position and velocity as functions of time.

For further analysis, it is convenient to introduce a coordinate system. An orthogonal system composed of three mutually perpendicular unit vectors is useful for trajectory problems. Assume that the x-axis is horizontal and pointed downrange, its y-axis is also horizontal but pointed cross range, and its z-axis is vertical (Fig. A1).

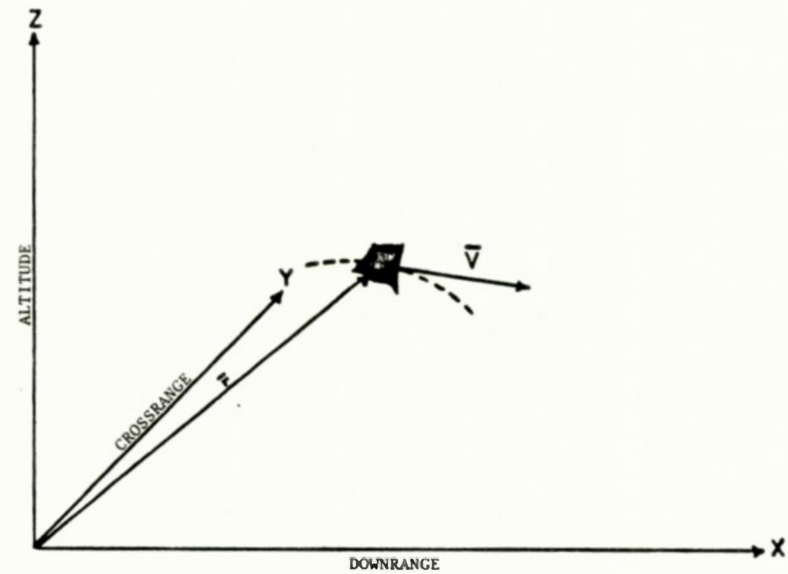

Figure A1. Simple trajectory coordinates.

To establish fragment time and position split the last equation into three scalar equations, corresponding to the coordinate system.

$$\ddot{x} = 0 \qquad \ddot{y} = 0 \qquad \ddot{z} = -g$$

$$\dot{x} = \int_0^t \ddot{x}dt \qquad \dot{y} = \int_0^t \ddot{y}dt \qquad \dot{z} = \int_0^t \ddot{z}dt$$

$$\dot{x} = C_1 \qquad \dot{y} = C_2 \qquad \dot{z} = C_3 - gt$$

Constants of integration, C_1, C_2 and C_3 must be evaluated. This is done by checking the valves for x, y and z at the initial condition t = 0.

At t = 0:

$\dot{x}_0 = V_{x_i}$ initial velocity in x-direction

$\dot{y}_0 = 0$ assume initially no cross range motion

$\dot{z}_0 = V_{z_i}$ initial velocity in z-direction

therefore,

$$C_1 = V_{x_i} \qquad C_2 = 0 \qquad C_3 = V_{z_i}$$

integrating again,

$$x = \int_0^t \dot{x}dt \qquad y = \int_0^t \dot{y}dt \qquad z = \int_0^t \dot{z}dt$$

$$x = V_{x_i}t + C_4 \qquad y = C_5 \qquad z = -\frac{1}{2}gt^2 + V_{z_i}t + C_6$$

Similarly evaluating C_4, C_5 and C_6 we find that

$$x = V_{x_i}t + x_i \qquad y = 0 \qquad z = -\frac{1}{2}gt^2 + v_{z_i}t + z_i$$

Where x_i and z_i give the known starting fragment position.

The equations for x and z give position components as functions of time since fragment movement.

The equations for $\dot{x}$ and $\dot{z}$ give velocity components, also as a function of time.

$$\dot{x} = V_{x_i} \qquad \dot{z} = -gt + V_{z_i}$$

These equations do not give any intuitive feel for the geometry of the trajectory. The geometry can be deduced only from a form of z = a function of x.

Solving the x-equation for t:

$$t = \frac{x - x_i}{V_{x_i}}$$

Substituting into the z-equation:

$$z = \frac{1}{2} g\left(\frac{x - x_i}{V_{x_i}}\right)^2 + V_{z_i}\left(\frac{x - x_i}{V_{x_i}}\right) + z_i$$

this is a form similar to

$$z = ax^2 + bx + c$$

which describes a parabola. Therefore, the trajectory is parabolic.

Figure A2 depicts a typical two-dimensional trajectory. The following defines the variables shown in the figure.

V_i = initial velocity

Θ_i = initial flight path angle, measured up from the horizontal

$V_{x_i} = V_i \cos \Phi_i$

$V_{z_i} = V_i \sin \Phi_i$

x_i and z_i = coordinates of starting point

x_f and x_f = coordinates of point downrange at same height as initial point ($z_f = z_i$)

$R_s = x_f - x_i$ = symmetric range

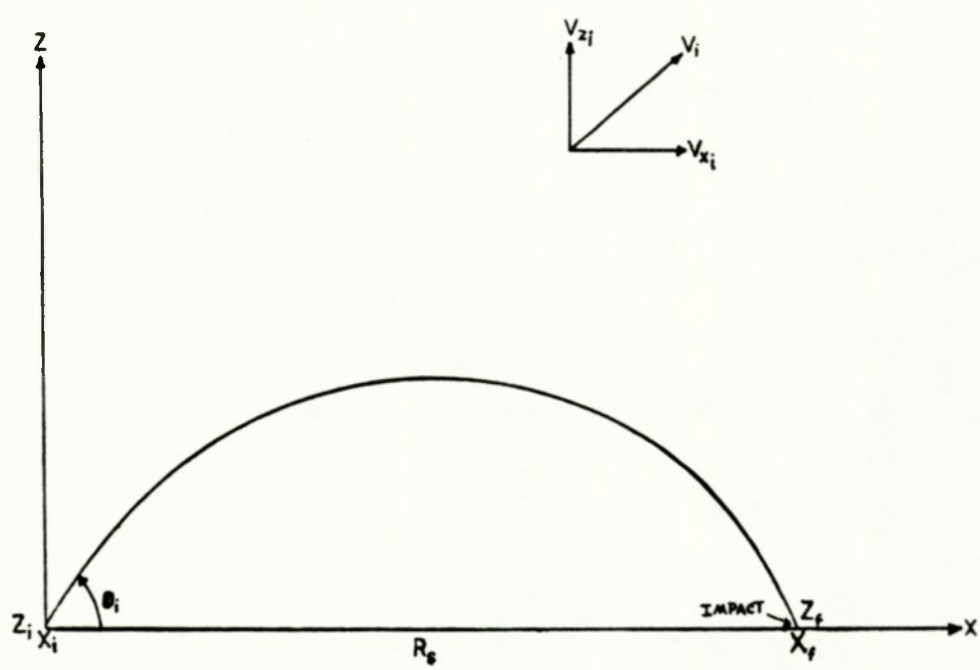

Figure A2. Simple flight profile.

Substituting in the z = f(x) equation:

$$z_f = \frac{1}{2} g \left(\frac{x_f - x_i}{V_{x_i}}\right)^2 + V_{z_i} \left(\frac{x_f - x_i}{V_{x_i}}\right) + z_i$$

$$z_f - z_i = 0 = -\frac{1}{2} g \left(\frac{R_s}{V_i \cos\Phi_i}\right)^2 + R_s \frac{V_i \sin\Phi_i}{V_i \cos\Phi_i}$$

Solving for R_s as a function of V_i and Φ_i:
(One solution is $R_s = 0$, which is trivial.)

$$\frac{1}{2} g \frac{R_s^2}{V_i^2 \cos^2\Phi_i} = \frac{R_s \sin\Phi_i}{\cos\Phi_i}$$

$$\frac{1}{2} g \frac{R_s}{V_i^2} = \sin\Phi_i \cos\Phi_i = \frac{1}{2} \sin 2\Phi_i$$

or

$$R_s = \frac{V_i^2}{g} \sin 2\Phi_i$$

In this form it is seen at once that, for a given velocity V_i, the range is a maximum when the $\sin 2\Phi_i$ is a maximum.

Since the sin has its maximum value of unity for an angle of 90 deg, the angle Φ_i above will be 45 deg. Furthermore, the range for any angle any number of degrees greater than 45 deg will be equal to that for an equal number of degrees less than 45 deg.

Two other values, often of concern to trajectory analysis, are T, time of flight, and Z_{max}, maximum altitude. The remainder of this discussion will derive expressions for these values.

Since the time required to reach the highest point is equal to the time required to fall the same distance (no drag), the formula for free-fall may be used. The equation for an object falling from rest is:

$$V_z = gt$$

by solving for t and substituting for V_z, find:

$$t = \frac{V_z}{g} = \frac{V_i \sin\Phi_i}{g}$$

Since t is the time to rise, or the time to fall, the total time of flight will be 2t. Therefore the time of flight T is:

$$T = \frac{2V_i \sin\Phi_i}{g}$$

To find the maximum trajectory height, Z_{max} is proportional to the square of the time and is given by:

$$Z_{max} = \frac{1}{2} gt^2$$

from before, $V_z = gt$

so, $V^2 = 2gZ_{max}$

solving for Z_{max}, obtain

$$Z_{max} = \frac{V_z^2}{2g}$$

Substituting for V_z we have

$$Z_{max} = \frac{V_i \sin\Phi_i}{2g}$$

APPENDIX B

This appendix presents the calculational steps from Bishop's work as presented in Reference 6. It is meant to allow for simple calculations using the appropriate steps. Knowing the basics of the problem, the range of the fragment can be estimated.

BISHOP'S ANALYSIS (Ref. 6)

The procedure for calculating the maximum range of a projectile can be developed simply from the characteristic distance equation

<u>eqn B-1</u> $$K_a^{-1} = (0.167)(S_a)(C_D^{-1})_a\ (\rho_p/\rho_a)$$

where ρ_a = Average value of the air density (g/cc) along the trajectory

ρ_p = Density of projective (g/cc)

$(C_D^{-1})_a$ = Average value of C_D^{-1} along the trajectory, where C_D is the drag coefficient at any point along the trajectory (dimensionless)

S_a = Effective thickness (in) of the projectile, averaged along the trajectory

in conjunction with the rotation correction factor

<u>eqn B-2</u> $$\frac{K_r^{-1}}{K_f^{-1}} = (1.57)(1 + R_E)^{-1}$$

where K_r^{-1} = Characteristic distance for the tumbling rotational case

K_f^{-1} = Characteristic distance which corresponds to a nontumbling plate

R_E = Thick plate shape factor (dimensionless) = $\frac{\text{edge area}}{\text{face area}}$

Taking average values along the trajectory (subscript <u>a</u>) the corrected characteristic distance is determined from equation B-2.

<u>eqn B-3</u> $$(K_r^{-1})_a = (1.57)(K_f^{-1})_a\ (1+R_E)^{-1}$$

in which $(K_r^{-1})_a$ is the corrected value of $(K_f^{-1})_a$ due to (tumbling) rotation, and $(K_f^{-1})_a$ is defined by an equation similar to equation B-1.

<u>eqn B-4</u> $$(K_f^{-1})_a = (0.167)(S_f)(C_D^{-1})_a\ (\rho_p/\rho_a)$$

Equation B-4 is identical to equation B-1 except S_a is replaced by S_f. The quantity S_f is defined as the fragment (flat-plate) volume divided by the face area A_f. Thus S_f is the same as the quantity S_a with A replaced by A_f. Therefore, S_f is constant and is practially equal to the fragment thickness S (measured in inches), unless the fragment is bent or curled.

When the fragment consists of a bent, curled, or folded plate, the previous definitions of S must be extended in order to estimate the corresponding range distances. The effective fragment thickness S_f has been defined as

eqn B-5 $$S_f = V_f/A_f$$

where

S_f = Effective thickness (inches)

V_f = Fragment volume (in^3)

A_f = Face area (in^2)

For a flat plate, the face area A_f is unambiguous, but the "face area" A_f of a bent, curled, or folded plate is as yet undefined, and has no meaning. In order to extend the definition, we refer to the following equation:

eqn B-6 $$A = A_f \cos H + A_e \sin H$$

for $$0^o \leq H \leq 90^o$$

which gives the frontal projected area A in terms of the two areas A_e and A_f.

From equation B-6, it is clear that the "edge-area" A_e is the minimum frontal projected area, and this minimum occurs when the inclination angle H is equal to 90 degrees. This conclusion applies as yet only to a flat plate. By analogy, let us define A_e as the minimum frontal projected area of a bent, curled, or folded plate and let us choose the angle H so that H is 90 degrees

when the bent, curled, or folded plate presents its minimum frontal projected area. Then, in order to preserve the form of equation B-6, we define A_f as the frontal projected area of the bent, curled, or folded plate when the inclination angle H is zero. Obviously this occurs when the fragment has turned 90 degrees from the position where it presented its minimum frontal projected area, defined as A_e. It follows from this extended definition that the generalized "face area" A_f is always approximately equal to the maximum frontal projected area of the fragment.

Equation B-4 gives the value of K^{-1} averaged along the trajectory, which results in equation B-1 with subscript a, and also with the variable projected area A replaced by the constant face area A_f. Hence the subscript f appears in eqution B-4 which refers to a nontumbling fragment.

Substituting the expression for (K_f^{-1}) from equation B-4 into B-3 we obtain the characteristic distance $(K_r^{-1})_a$ for a rotating (tumbling) projectile

eqn B-7 $K = (0.262)(S_f)(C_D^{-1})_a(p/ a)(1+R_E)^{-1}$

eqn B-8 $K = (K_r^{-1})_a$

by definition.

The general method for calculating a typical maximum horizontal range distance (x_R) proceeds according to the following schedule:

Step No.		Calculation Steps
1	K	characteristic distance, feet, from equation B-7 above
2	r	from $r = K^{-1} (V_B^2/g)$
3	B_m	from Figure B-1, using r from Step 2

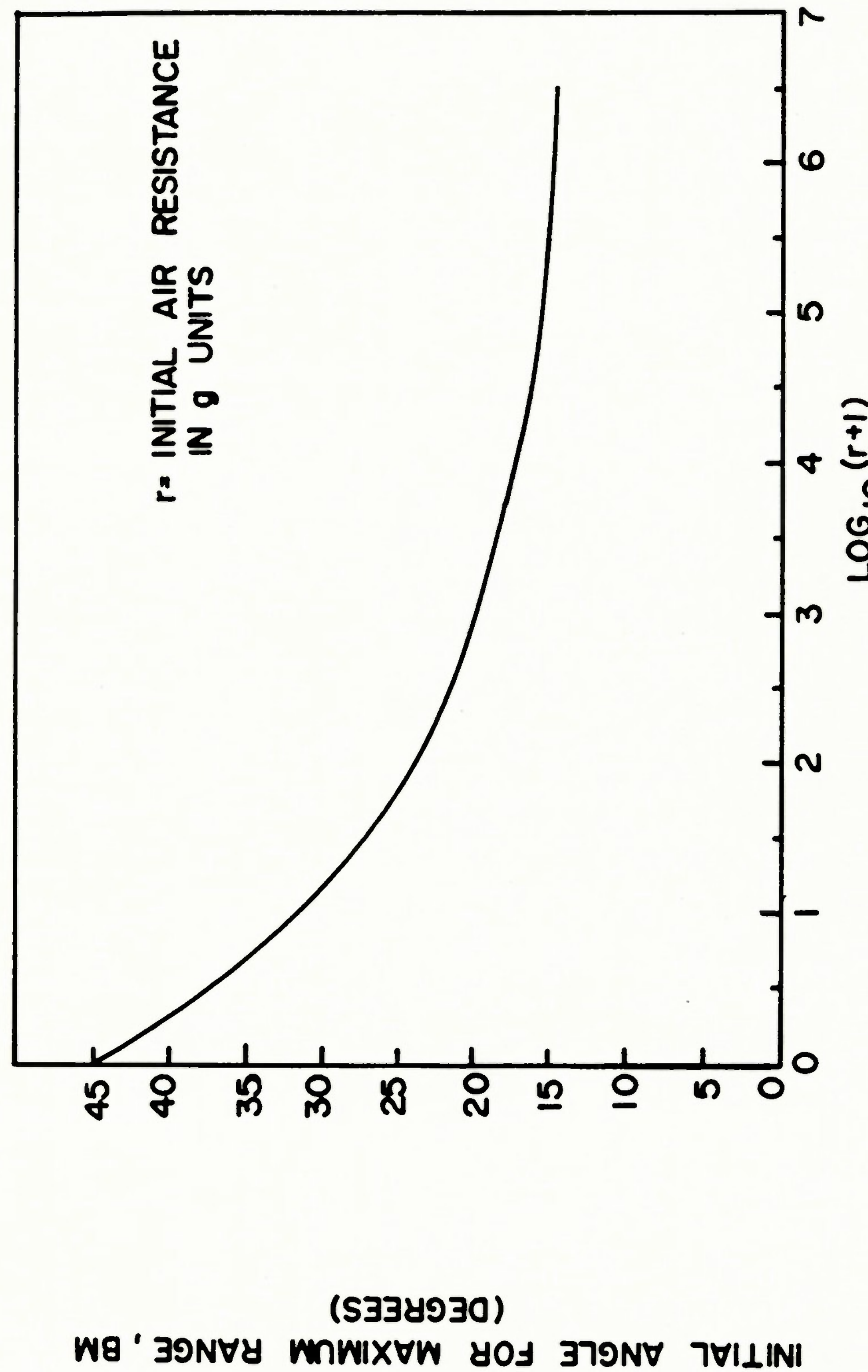

FIGURE B-1. INITIAL ANGLE FOR MAXIMUM RANGE

Step No.		Calculation (Continued)
4	Q	from $Q = \cos B_m$
5	w	from $w = KQ$
6	F	from $F=2r \sin B_m$
7	(Z_R)	from Figure B2
8	(x_R)	maximum horizontal range, feet, from $(x_R) = (0.5)\, w\, (Z_R)$

In order to carry out all the steps it is necessary to know the magnitudes of the following quanitites:

S_f	$\frac{\text{Fragment Volume}}{\text{Face area}}$ = Effective fragment thickness (inches)
$(C_D)_a$	Drag coefficient, averaged along the trajectory (dimensionless)
ρ_p	Projectile density (g/cc), numerically equal to the specific gravity relative to water
ρ_a	Air density (g/cc), averaged along the trajectory
R_E	Dimensionless shape factor, $\frac{\text{Edge area}}{\text{Face area}}$
V_B	Initial speed of fragment (ft/sec)
g	Acceleration due to gravity

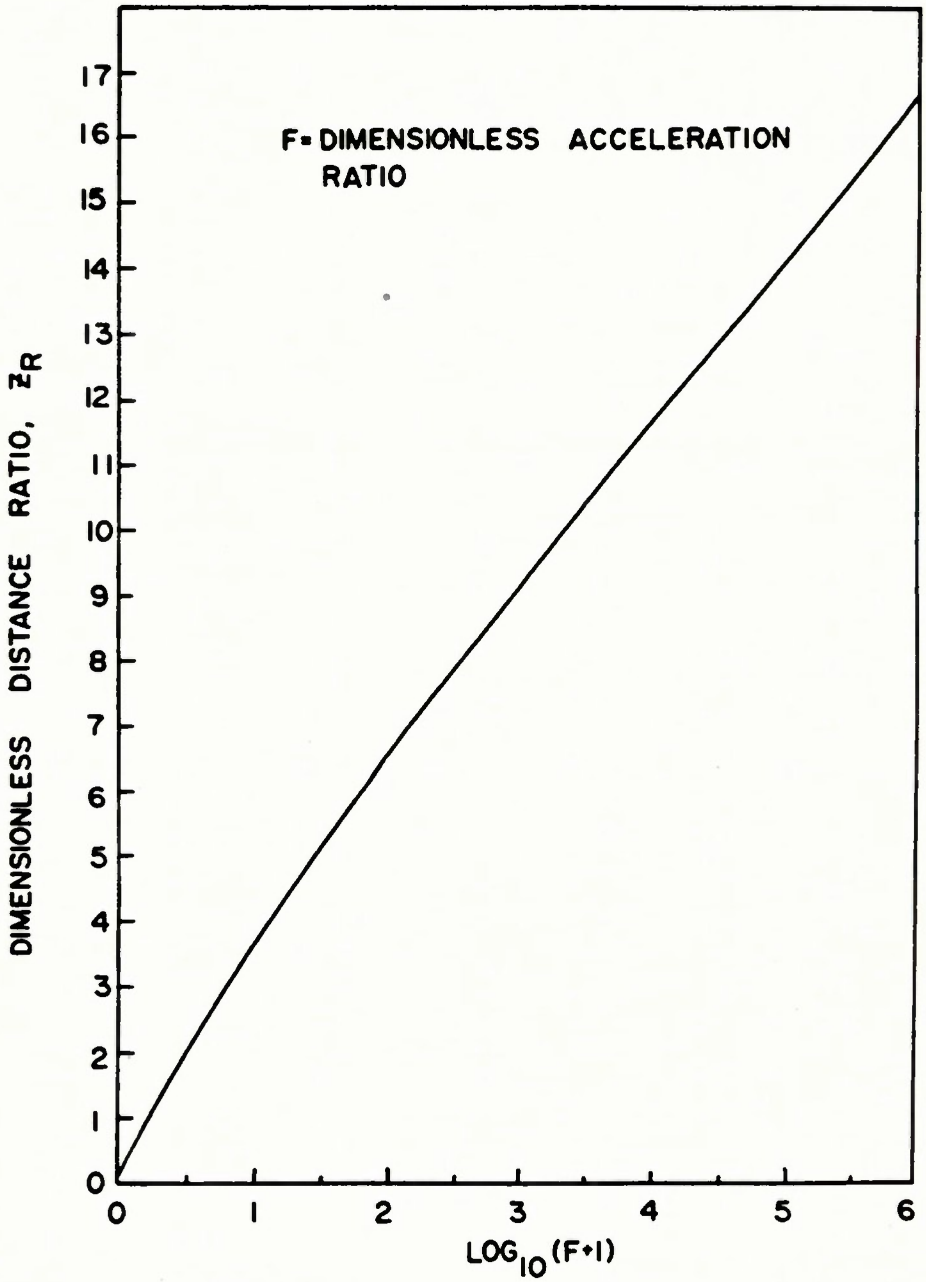

FIGURE B-2. SOLUTION OF RANGE EQUATION, WIDE RANGE OF Z_R

APPENDIX C

This appendix contains the results of calculations using Bishop's methodology. All the variables required (and steps) indicated in Appendix B are presented. The key variables are: L, W, T, VEL, and XR which refer to length (in), width (in), thickness (in) of the fragment, initial velocity of the fragment (ft/s), and distance to impact point (ft), respectively.

XR	L	W	T	SF	RE	K	R	BM	Q	W	F	ZR	VEL	
2584.72	1	1	.375	.375	.375	629.8	1059.3	19.41	.943	593.9	704.2	8.70	4635	
3607.22	1	2	.500	.500	.250	923.7	722.3	19.93	.940	868.4	492.5	8.31	4635	
5605.63	2	2	1.00	1.00	.500	1539	433.4	20.7	.935	1439	306.9	7.78	4635	
3155.21	4	2	.375	.375	.094	791.7	842.7	19.7	.941	745.3	568.5	8.47	4635	
3277.68	8	4	.375	.375	.047	827.2	806.6	19.77	.941	778.4	545.8	8.39	4635	
3342.8	16	8	.375	.375	.023	846.1	788.5	19.80	.940	796.1	534.4	8.39	4635	
3376.41	32	16	.375	.375	.012	855.9	779.5	19.82	.941	805.2	528.6	8.38	4635	
3380.19	36	24	.375	.375	.010	857.0	778.5	19.82	.940	806.2	528.0	8.38	4635	
3387.77	48	12	.375	.375	.008	859.3	776.5	19.83	.940	808.3	526.8	8.38	4635	
2260.79	1	1	.375	.375	.375	629.8	392.4	20.90	.934	588.3	279.9	7.68	2820	
3134.32	1	2	.500	.500	.250	923.7	267.4	21.62	.929	858.7	197.9	6.79	2820	
4823.29	2	2	1.00	1.00	.500	1539	160.4	22.71	.922	1420	123.9	6.79	2820	
2749.08	4	2	.375	.375	.094	791.7	311.9	21.32	.931	737.5	226.9	7.45	2820	
2853.59	8	4	.375	.375	.047	827.2	298.6	21.41	.931	770.1	217.9	7.41	2820	
2909.13	16	8	.375	.375	.023	846.1	291.8	21.45	.930	787.5	213.5	7.39	2820	
2937.77	32	16	.375	.375	.012	855.9	288.5	21.47	.930	796.5	211.3	7.37	2820	

XR	L	W	T	SF	RE	K	R	BM	Q	W	F	ZR	VEL	
2941.00	36	24	.375	.375	.010	857.0	288.1	21.48	.930	797.5	211.0	7.37	2820	
2947.46	48	12	.375	.375	.008	859.3	287.4	21.48	.930	799.6	210.5	7.37	2820	
1008.54	1	1	.375	.375					.873			7.12	362.2	
1123.15	1	2	.375	.375					.818			6.24	362.2	
1168.43	1	3	.375	.375					.799			5.94	362.2	
1192.70	1	4	.375	.375					.788			5.79	362.2	
1207.84	1	5	.375	.375					.782			5.71	362.2	
1218.18	1	6	.375	.375					.778			5.65	362.2	
1225.69	1	7	.375	.375					.775			5.61	362.2	
1231.40	1	8	.375	.375					.773			5.57	362.2	
1235.88	1	9	.375	.375					.771			5.55	362.2	
1239.49	1	10	.375	.375					.769			5.53	362.2	
1242.46	1	11	.375	.375					.768			5.51	362.2	
1244.95	1	12	.375	.375					.767			5.49	362.2	
1008.54	5	1	.375	.375					.873			7.11	362.2	

XR	L	W	T	SF	RE	K	R	BM	Q	W	F	ZR	VEL	
1123.54	5	2	.375	.375					.818			6.24	362.2	
1168.43	5	3	.375	.375					.799			5.94	362.2	
1192.70	5	4	.375	.375					.788			5.79	362.2	
1207.84	5	5	.375	.375					.782			5.70	362.2	
1218.18	5	6	.375	.375					.778			5.65	362.2	
1225.69	5	7	.375	.375					.775			5.60	362.2	
1231.40	5	8	.375	.375					.772			5.57	362.2	
1235.88	5	9	.375	.375					.771			5.55	362.2	
1239.49	5	10	.375	.375					.769			5.52	362.2	
1242.46	5	11	.375	.375					.768			5.51	362.2	
1244.95	5	12	.375	.375					.767			5.49	362.2	
1008.54	48	1	.375	.375					.873			7.10	362.2	
1218.18	48	6	.375	.375					.778			5.64	362.2	
1242.46	48	11	.375	.375					.768			5.51	362.2	
1251.86	48	16	.375	.375					.764			5.46	362.2	
1256.85	48	21	.375	.375					.762			5.43	362.2	

APPENDIX D

This appendix contains the analysis of the ground-based photographic data as perceived by the Physical Sciences Laboratory. The first item to note is the camera number listed on the second line. The third line indicates the fragment number, camera number, and the plane angle (respective to the test bed coordinates) perpendicular to the view of the camera. Also presented in the fourth line is the deduced photometric size of the fragment and its flight attitude. The fragment numbers also correspond to the numbered trajectories in Figures 24 through 26. The data present the position-time and calculated velocities of the fragment throughout its trajectory.

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 1 1

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 1 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.72M, W =0.21M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1006	19.9	74.7	
0.1034	20.2	75.0	136.5
0.1062	20.8	77.5	941.8
0.1089	21.4	78.8	488.5
0.1145	22.4	81.1	447.1
0.1172	22.8	82.5	554.3
0.1228	23.8	84.8	451.0
0.1256	24.6	86.2	549.3

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 2 1

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 2 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.40M, W =0.09M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1200	3.1	64.2	
0.1228	3.1	65.2	361.8
0.1256	3.3	66.0	317.0
0.1283	3.3	67.1	381.7
0.1311	3.3	68.2	416.4
0.1339	3.2	69.3	374.2
0.1366	3.3	70.4	397.4
0.1394	3.4	71.4	384.3
0.1422	3.4	72.2	286.0
0.1616	3.9	79.7	383.5
0.1644	4.0	80.7	390.6
0.1671	4.0	81.5	266.5
0.1699	4.2	82.4	316.9
0.1727	4.1	83.7	477.2
0.1754	4.2	84.7	383.6
0.1782	4.3	85.6	323.0
0.1810	4.2	86.5	319.6
0.1838	4.2	87.4	320.8

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 3 1
FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA
FRAGMENT 3 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG
APPARENT SIZE: L =0.32M, W =0.09M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1200	-1.9	64.2	
0.1228	-1.8	65.2	388.1
0.1256	-1.7	66.2	340.0
0.1283	-1.9	66.8	235.2
0.1311	-2.0	67.9	396.5
0.1339	-2.0	68.9	335.8
0.1366	-2.2	69.9	384.2
0.1394	-2.1	70.9	353.8
0.1422	-2.0	71.8	327.6
0.1450	-2.0	72.8	354.2
0.1477	-2.3	73.9	393.3
0.1505	-2.4	74.9	363.9
0.1533	-2.3	75.7	299.2
0.1560	-2.2	76.8	381.1
0.1588	-2.2	77.9	397.5
0.1616	-2.3	78.6	274.6
0.1644	-2.4	79.8	410.3
0.1671	-2.4	80.7	335.6
0.1699	-2.5	81.6	308.3
0.1727	-2.4	82.8	456.9
0.1754	-2.7	83.4	223.5
0.1782	-2.6	84.4	340.1
0.1810	-2.6	85.4	333.1
0.1838	-2.8	86.3	324.0
0.1865	-2.9	87.2	309.0
0.1893	-2.9	88.2	362.0

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 4 1

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 4 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.56M, W =0.14M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1200	-7.3	54.2	
0.1228	-7.4	55.0	276.1
0.1256	-7.5	55.8	275.1
0.1283	-7.8	56.5	265.5
0.1311	-8.1	57.5	388.4
0.1366	-8.3	59.1	297.9
0.1394	-8.5	59.7	225.2
0.1422	-8.5	60.6	309.7
0.1450	-8.6	61.3	256.0
0.1477	-8.9	62.2	349.2
0.1505	-9.1	63.1	301.6
0.1533	-9.2	63.9	292.4
0.1560	-9.2	64.7	304.0
0.1588	-9.4	65.4	251.7
0.1616	-9.7	66.2	303.8
0.1644	-9.8	67.0	302.3
0.1671	-9.9	67.8	263.9
0.1699	-10.1	69.0	443.6
0.1727	-10.1	69.5	170.9
0.1754	-10.3	70.2	272.8
0.1782	-10.4	71.0	275.4
0.1810	-10.4	72.0	389.2
0.1838	-10.6	72.5	186.0
0.1865	-10.8	73.2	252.6
0.1893	-10.9	73.9	268.7
0.1921	-10.9	74.9	327.4
0.1948	-11.2	75.6	277.1
0.1976	-11.3	76.3	255.2
0.2004	-11.3	77.1	293.7
0.2032	-11.5	77.9	275.0
0.2059	-11.6	78.5	232.9
0.2087	-11.8	79.3	281.8
0.2115	-11.7	80.0	267.1
0.2142	-11.9	80.7	260.5

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 4 2

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 4 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.56M, W =0.14M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.2170	-12.1	81.4	251.3
0.2198	-12.1	82.1	240.1
0.2226	-12.2	83.1	364.5
0.2253	-12.3	83.9	290.2
0.2281	-12.5	84.4	207.6
0.2309	-12.7	84.9	193.1
0.2336	-12.9	85.9	340.7
0.2364	-13.1	86.6	282.0
0.2392	-13.1	87.1	174.3
0.2420	-13.2	87.8	266.8

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 5 1

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 5 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.57M, W =0.23M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1200	-19.5	64.9	
0.1228	-19.8	65.9	390.8
0.1256	-20.2	67.0	397.4
0.1283	-20.8	67.8	345.6
0.1311	-21.2	68.9	437.9
0.1339	-21.8	70.1	479.2
0.1366	-22.1	71.1	362.7
0.1394	-22.5	72.1	400.0
0.1422	-22.7	73.1	346.1
0.1505	-24.2	76.3	420.3
0.1533	-24.3	77.2	342.1
0.1560	-24.6	78.3	411.2
0.1588	-25.0	79.3	388.8
0.1616	-25.4	80.2	365.2
0.1644	-25.8	81.2	378.4
0.1671	-26.2	82.3	421.7
0.1699	-26.5	83.3	367.7
0.1727	-27.0	84.2	373.8
0.1754	-27.4	85.3	421.9
0.1782	-27.6	86.2	309.5
0.1810	-28.1	87.3	456.3
0.1838	-28.4	88.5	443.7

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 6 1

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 6 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.56M, W =0.18M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1228	6.9	64.0	
0.1256	7.2	65.2	443.2
0.1283	7.2	66.0	280.0
0.1311	7.3	67.1	390.2
0.1339	7.4	68.2	418.8
0.1366	7.5	69.2	367.8
0.1394	7.6	70.2	340.0
0.1422	7.9	71.2	369.3
0.1450	8.2	72.3	433.5
0.1477	8.1	73.6	463.5
0.1505	8.1	74.6	346.8
0.1533	8.4	75.7	385.8
0.1588	8.7	77.5	335.5
0.1616	9.2	79.0	574.2
0.1671	9.6	81.0	351.9
0.1699	9.9	81.9	351.3
0.1727	9.9	83.0	400.3
0.1754	9.8	83.3	103.5
0.1810	10.1	85.0	311.2
0.1838	10.1	86.4	483.6
0.1865	10.3	87.5	428.4

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 7 1

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 7 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.73M, W =0.20M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1366	-23.1	60.6	
0.1394	-23.7	61.5	395.2
0.1422	-24.1	62.2	275.0
0.1450	-24.3	63.0	304.5
0.1477	-25.0	63.9	401.9
0.1505	-25.5	64.8	375.6
0.1533	-25.9	65.6	316.0
0.1560	-26.2	66.5	319.7
0.1588	-26.8	67.2	317.6
0.1616	-27.4	68.1	386.4
0.1644	-27.8	68.8	278.4
0.1671	-28.2	69.6	317.5
0.1699	-28.8	70.5	420.0
0.1727	-29.3	71.3	321.8
0.1754	-29.7	71.9	244.7
0.1782	-30.1	72.6	304.1
0.1810	-30.7	73.6	382.2
0.1838	-31.2	74.3	311.4
0.1865	-31.6	75.0	308.9
0.1893	-32.0	76.0	374.3
0.1921	-32.4	76.7	289.2
0.1948	-33.0	77.2	244.7
0.1976	-33.3	78.0	308.9
0.2004	-33.6	79.0	367.8
0.2032	-34.3	79.7	351.0
0.2059	-34.8	80.4	295.5
0.2087	-35.2	81.1	305.5
0.2115	-35.6	82.0	334.1
0.2142	-36.0	82.9	363.2
0.2170	-36.6	83.4	249.4
0.2198	-37.0	84.2	339.0
0.2226	-37.2	84.9	246.5
0.2253	-37.5	85.6	296.7
0.2281	-38.2	86.4	331.9

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 7 2

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 7 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.73M, W =0.20M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.2309	-38.6	87.2	318.2
0.2336	-38.9	87.8	253.1
0.2364	-39.4	88.7	382.3
0.2392	-40.0	89.3	281.5

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 8 1

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 8 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.52M, W =0.19M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1450	-26.1	71.3	
0.1477	-26.8	72.2	378.6
0.1505	-27.3	73.3	434.7
0.1533	-27.6	73.9	249.8

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 9 1

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 9 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.60M, W =0.18M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1450	-30.6	73.5	.
0.1477	-31.3	74.7	479.2
0.1505	-32.0	75.6	410.4
0.1560	-32.7	77.6	386.9

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 10 1

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 10 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.69M, W =0.20M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1450	-37.2	82.9	
0.1477	-38.1	84.1	510.6
0.1505	-38.9	85.2	520.1
0.1533	-39.5	86.4	458.8
0.1560	-40.1	87.5	446.5
0.1588	-40.7	88.4	395.7

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 11 1

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 11 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.51M, W =0.19M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1450	-14.9	64.3	
0.1477	-15.4	65.3	398.7
0.1505	-15.7	66.2	341.1
0.1533	-15.9	67.0	291.6
0.1560	-16.1	67.9	349.7
0.1588	-16.3	68.6	266.8
0.1644	-17.0	70.2	294.9
0.1671	-17.2	71.1	331.5
0.1699	-17.5	72.1	391.2
0.1727	-17.8	72.9	303.4
0.1754	-18.1	73.6	257.2
0.1782	-18.3	74.3	271.8
0.1810	-18.7	75.3	375.0
0.1838	-19.0	76.1	333.5
0.1865	-19.1	77.0	305.0
0.1893	-19.4	77.8	333.6
0.1921	-19.6	78.5	250.5
0.1948	-20.0	79.1	251.1
0.1976	-20.2	80.1	351.6
0.2004	-20.4	81.0	334.9
0.2032	-20.8	81.8	319.1
0.2059	-21.0	82.5	252.4
0.2087	-21.4	83.3	324.1
0.2115	-21.6	84.2	336.7
0.2142	-21.8	85.0	297.4
0.2170	-22.2	85.7	284.6
0.2198	-22.3	86.5	273.3
0.2226	-22.4	87.3	296.7
0.2253	-22.6	88.0	259.1
0.2281	-23.2	88.9	375.1
0.2309	-23.3	89.5	202.3

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 12 1

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 12 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.78M, W =0.33M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1477	-39.3	63.8	
0.1505	-40.2	64.4	338.9
0.1533	-40.5	65.1	272.1
0.1560	-41.0	65.6	256.7
0.1588	-41.5	66.1	266.2
0.1616	-42.3	66.8	358.2
0.1644	-42.8	67.5	319.9
0.1671	-43.2	68.0	236.6
0.1699	-43.9	68.7	317.3
0.1727	-44.4	69.3	282.0
0.1754	-44.9	69.9	286.0
0.1782	-45.5	70.4	259.2
0.1810	-46.0	71.1	322.0
0.1865	-47.1	72.1	260.4
0.1893	-47.3	72.8	323.0
0.1921	-48.1	73.4	267.4
0.1948	-48.8	73.8	259.9
0.1976	-49.2	74.3	239.1
0.2004	-49.6	75.1	297.6
0.2032	-50.3	75.6	294.3
0.2059	-50.8	76.1	258.4
0.2087	-51.4	76.8	315.1
0.2115	-51.6	77.2	182.1
0.2142	-52.3	77.8	294.8
0.2170	-52.8	78.2	241.8
0.2198	-53.2	78.8	239.2
0.2226	-53.6	79.4	276.5
0.2253	-54.0	80.0	241.3
0.2281	-54.6	80.5	273.3
0.2309	-55.1	81.3	337.5
0.2336	-55.6	81.8	258.7
0.2364	-55.9	82.1	148.4
0.2392	-56.4	82.6	239.7
0.2420	-56.9	82.9	218.2

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 12 2

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 12 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.78M, W =0.33M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.2447	-57.4	83.3	211.8
0.2475	-57.8	84.1	317.9
0.2503	-59.0	85.1	547.1

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 13 1

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 13 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.65M, W =0.29M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1505	12.6	68.5	
0.1533	13.0	69.4	361.4
0.1560	13.2	70.2	279.2
0.1588	13.4	71.1	361.9
0.1616	13.7	72.2	379.0
0.1671	14.3	74.0	339.7
0.1727	14.9	75.5	295.0
0.1754	14.6	76.2	220.7
0.1782	14.9	77.0	301.0
0.1838	15.2	78.7	305.2
0.1865	15.5	79.6	354.9
0.1893	15.7	80.4	310.9
0.1921	16.0	81.2	287.8
0.1948	16.0	81.8	220.6
0.1976	16.2	82.8	356.7
0.2004	16.5	83.6	298.3
0.2032	16.6	84.3	277.8
0.2059	16.7	85.0	249.6
0.2087	16.9	85.6	222.7
0.2115	17.4	86.7	402.9
0.2142	17.4	87.6	341.2

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 14 1

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 14 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.28M, W =0.23M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1505	-69.3	11.8	
0.1533	-70.1	12.1	292.3
0.1560	-70.6	12.3	197.2
0.1588	-71.2	12.3	215.0
0.1616	-72.0	12.5	281.2
0.1644	-72.5	12.8	211.9
0.1671	-73.1	12.9	217.4
0.1699	-73.7	13.4	247.2
0.1727	-74.3	13.5	205.3
0.1754	-74.8	13.7	216.3
0.1782	-75.4	14.0	205.8
0.1810	-76.0	14.1	228.6
0.1838	-76.7	14.4	257.8

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 15 1

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 15 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.59M, W =0.14M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1754	4.8	75.2	
0.1782	4.9	75.9	242.0
0.1810	4.8	77.0	386.8
0.1838	4.9	77.8	294.7
0.1865	5.0	78.5	268.1
0.1893	5.1	79.1	228.0
0.1921	5.2	79.9	230.3
0.1948	5.1	80.8	300.0
0.1976	5.2	81.6	295.1
0.2004	5.3	82.5	350.2
0.2059	5.4	83.7	208.5
0.2087	5.5	84.8	391.2
0.2115	5.6	85.5	276.7
0.2142	5.6	85.1	197.7
0.2170	5.4	86.7	234.9
0.2198	5.7	87.6	320.7
0.2226	5.8	88.5	323.7

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FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 16 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.58M, W =0.14M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1810	-13.1	71.5	
0.1838	-13.2	72.3	297.6
0.1865	-13.4	73.1	305.4
0.1893	-13.6	73.9	230.1
0.1921	-13.4	74.3	163.1
0.1948	-14.0	75.4	396.9
0.1976	-14.3	76.4	388.7
0.2004	-14.4	77.2	288.4
0.2032	-14.4	77.7	186.4
0.2059	-14.8	78.8	400.7
0.2087	-15.0	79.6	288.3
0.2115	-15.1	80.3	260.1
0.2142	-15.4	81.0	289.6
0.2170	-15.7	81.5	207.8
0.2226	-15.8	83.7	378.4
0.2253	-16.0	84.5	303.1
0.2281	-16.2	85.0	183.7
0.2309	-16.3	85.6	242.8
0.2336	-16.5	86.4	300.5
0.2364	-16.5	87.2	263.1
0.2392	-17.1	88.1	356.3
0.2420	-17.2	88.9	314.0

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FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 17 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.36M, W =0.36M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1865	-72.5	11.0	
0.1893	-73.1	10.9	226.3
0.1921	-73.5	11.1	162.9
0.1948	-74.1	11.1	183.0
0.1976	-74.7	11.3	227.5
0.2004	-75.3	11.5	240.1
0.2032	-75.8	11.5	176.3
0.2059	-76.4	11.6	202.2
0.2087	-76.9	11.6	211.0
0.2115	-77.4	11.8	185.1
0.2142	-77.9	12.0	191.9
0.2170	-78.7	11.9	284.9
0.2198	-79.1	12.1	132.2
0.2226	-79.6	12.2	174.5
0.2253	-80.2	12.4	238.2
0.2281	-80.8	12.4	206.9
0.2309	-81.3	12.5	175.5
0.2336	-81.9	12.6	220.7
0.2364	-82.5	12.7	229.4
0.2392	-32.8	12.8	120.6
0.2420	-83.3	12.7	160.5
0.2447	-83.9	13.0	249.9
0.2475	-34.5	13.1	216.0

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FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 18 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.53M, W =0.18M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1865	-6.4	68.6	
0.1893	-6.4	69.6	333.1
0.1921	-6.4	70.3	250.9
0.1948	-6.6	71.0	280.1
0.1976	-6.6	71.9	321.6
0.2004	-6.7	72.8	309.4
0.2032	-6.9	73.5	250.3
0.2059	-7.0	74.1	244.2
0.2087	-7.1	75.0	316.3
0.2115	-7.1	75.8	286.3
0.2142	-7.2	76.4	234.7
0.2170	-7.6	77.0	218.9
0.2198	-7.5	78.0	355.4
0.2226	-7.6	78.8	296.0
0.2253	-7.5	79.6	278.2
0.2281	-7.8	80.2	205.7
0.2309	-7.9	81.0	298.2
0.2336	-8.2	81.7	261.0
0.2364	-8.2	82.5	309.7
0.2392	-8.3	83.1	220.5
0.2420	-8.4	83.7	207.0
0.2447	-8.5	84.5	290.0
0.2475	-8.6	85.3	298.3
0.2503	-8.9	86.3	349.0
0.2530	-8.9	86.9	213.1
0.2558	-9.0	87.5	240.3
0.2585	-9.2	88.0	178.3
0.2614	-9.2	87.9	-24.9

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FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 19 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.92M, W =0.29M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.2087	-31.7	60.7	
0.2115	-32.0	61.4	256.8
0.2142	-32.5	61.8	224.6
0.2170	-33.0	62.3	219.6
0.2198	-33.2	62.9	225.3
0.2226	-33.6	63.5	272.5
0.2253	-33.9	64.1	232.3
0.2281	-34.5	64.4	215.0
0.2309	-34.6	65.0	209.5
0.2336	-35.2	65.6	265.5
0.2364	-35.8	66.1	282.2
0.2392	-36.1	66.4	136.0
0.2420	-36.3	67.0	241.0
0.2447	-36.7	67.4	191.7
0.2475	-37.3	67.9	239.7
0.2503	-37.8	68.6	308.1
0.2530	-38.0	69.2	236.9
0.2558	-38.4	69.7	225.2
0.2586	-38.8	70.1	214.1
0.2614	-39.2	70.3	116.7
0.2641	-39.6	70.8	226.2
0.2669	-40.0	71.5	299.3
0.2697	-40.3	72.0	203.4
0.2725	-40.7	72.7	306.1
0.2752	-40.9	73.0	111.9
0.2780	-41.5	73.7	320.5
0.2808	-41.9	74.3	280.7
0.2835	-42.3	74.7	187.6
0.2863	-42.8	75.2	244.4
0.2891	-43.0	75.6	160.4
0.2919	-43.3	76.0	195.9
0.2946	-43.9	76.7	301.6
0.2974	-44.2	76.9	129.4
0.3002	-44.4	77.6	257.5

PRE-DIRECT COURSE TEST, 7 OCT 1982
FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA
FRAGMENT 19 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG
APPARENT SIZE: L =0.92M, W =0.29M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.3029	-45.0	78.5	382.0
0.3057	-45.3	78.9	179.2
0.3085	-45.5	79.1	123.1
0.3113	-46.2	79.8	332.1
0.3140	-46.7	80.3	230.7
0.3168	-46.9	80.6	151.2
0.3196	-47.3	81.2	245.2
0.3223	-47.6	81.5	151.0
0.3251	-48.0	81.8	161.6
0.3279	-48.5	82.5	299.1
0.3307	-48.7	83.0	198.3
0.3334	-49.2	83.6	272.2
0.3362	-49.5	84.1	212.4
0.3390	-49.8	84.5	199.5
0.3417	-50.3	84.9	221.8
0.3445	-50.4	85.3	147.9

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FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 20 CAMERA F-3365 . AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.43M, W =0.30M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.2447	-67.5	14.4	
0.2475	-67.9	14.5	147.0
0.2503	-68.3	14.6	145.9
0.2530	-68.6	15.0	143.9
0.2558	-69.0	15.1	140.4
0.2586	-69.3	15.1	132.3
0.2614	-69.6	15.1	95.8
0.2641	-70.0	15.1	140.1
0.2669	-70.4	15.6	168.7
0.2697	-70.8	15.6	141.4
0.2725	-71.2	15.9	176.2
0.2752	-71.4	15.8	68.9
0.2780	-71.9	16.1	176.3
0.2808	-72.3	16.3	161.1
0.2835	-72.7	16.5	154.5
0.2863	-72.9	16.6	97.6
0.2891	-73.3	16.8	133.1
0.2919	-73.6	16.8	117.5
0.2946	-73.9	17.1	128.8
0.2974	-74.3	17.2	161.9
0.3002	-74.6	17.3	102.7
0.3029	-74.8	17.6	77.3
0.3057	-75.3	17.9	226.8
0.3085	-75.5	18.0	82.3
0.3113	-76.0	18.2	178.3
0.3140	-76.4	18.2	127.7
0.3168	-76.7	18.3	138.5
0.3196	-77.0	18.7	122.6
0.3223	-77.5	18.6	172.9

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FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 21 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.85M, W =0.30M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.2974	-68.0	20.2	
0.3002	-68.3	20.4	115.3
0.3029	-68.4	20.7	82.3
0.3057	-68.9	21.2	229.1
0.3085	-69.0	21.3	47.7
0.3113	-69.5	21.6	139.6
0.3140	-69.7	21.8	111.2
0.3168	-70.0	21.9	75.7
0.3279	-71.1	22.7	122.6
0.3334	-71.5	23.1	84.3
0.3445	-72.3	24.2	102.3

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 22 1

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 22 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.96M, W =0.23M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.2974	-69.1	19.9	
0.3002	-69.3	20.1	34.1
0.3029	-68.8	19.9	-193.8
0.3057	-69.8	20.4	415.7
0.3085	-70.1	20.4	88.1
0.3113	-70.3	20.6	105.8
0.3140	-70.6	20.9	130.3
0.3168	-70.9	20.8	97.3
0.3196	-71.1	20.8	67.4
0.3251	-71.5	21.1	83.4
0.3279	-71.7	21.0	36.5
0.3307	-71.9	21.0	86.2
0.3362	-72.4	21.6	110.7
0.3390	-72.4	21.5	10.1
0.3417	-72.9	21.8	179.1
0.3445	-72.7	21.8	-42.0
0.3473	-73.4	21.9	234.0
0.3501	-73.6	21.9	91.6
0.3528	-73.7	22.0	48.8
0.3556	-74.0	22.3	131.6
0.3584	-74.2	22.4	70.4
0.3611	-74.4	22.6	32.8
0.3639	-74.5	22.5	29.5
0.3667	-75.0	22.7	184.0
0.3695	-75.0	22.9	28.6
0.3722	-75.3	22.9	93.4
0.3750	-75.6	23.0	103.9
0.3778	-75.7	23.0	41.2
0.3805	-75.9	23.1	107.1
0.3833	-76.1	23.3	91.4
0.3889	-76.8	23.5	130.6
0.3916	-76.9	23.7	35.3
0.3944	-76.9	23.3	18.4
0.3999	-77.5	24.1	120.3

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FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 22 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =0.96M, W =0.23M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.4027	-77.7	24.3	74.1
0.4055	-77.9	24.4	90.2
0.4138	-78.6	24.5	83.7
0.4166	-78.8	24.6	77.2
0.4221	-79.3	24.8	98.0
0.4249	-79.5	24.9	84.2

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FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA
FRAGMENT 23 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG
APPARENT SIZE: L =0.57M, W =0.23M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.3196	-58.3	24.0	
0.3223	-58.3	24.0	5.1
0.3251	-58.4	24.1	16.6
0.3279	-58.3	24.1	-8.9
0.3307	-58.3	23.6	-87.6
0.3334	-58.2	24.3	79.1
0.3362	-58.2	24.5	30.0
0.3390	-58.5	24.5	70.4
0.3473	-59.3	25.0	112.9
0.3501	-59.7	25.5	216.6

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FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA
FRAGMENT 24 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG
APPARENT SIZE: L =0.82M, W =0.28M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.3473	-4.3	78.0	
0.3501	-4.3	78.1	69.1
0.3528	-4.3	78.6	157.0
0.3556	-4.2	79.0	160.0
0.3584	-4.3	79.7	247.8
0.3611	-4.2	79.8	47.4
0.3639	-4.2	80.4	184.7
0.3667	-4.3	80.9	206.4
0.3695	-4.2	81.3	141.7
0.3722	-4.3	81.6	84.0
0.3750	-4.3	81.7	47.4
0.3778	-4.4	82.2	193.6
0.3805	-4.3	82.7	167.8
0.3833	-4.4	83.3	214.5
0.3861	-4.5	83.5	90.8
0.3889	-4.4	84.0	175.4
0.3916	-4.4	84.5	157.9
0.3944	-4.5	84.7	76.8
0.3972	-4.4	85.3	208.8
0.3999	-4.4	85.8	185.2
0.4027	-4.4	86.3	178.4
0.4055	-4.6	86.6	126.2
0.4083	-4.4	86.7	44.1
0.4110	-4.5	87.4	240.7
0.4138	-4.7	87.6	85.6
0.4166	-4.7	88.1	178.0
0.4193	-4.7	88.6	178.8
0.4221	-4.7	88.9	114.9
0.4249	-4.6	89.2	94.8
0.4277	-4.7	89.6	132.2

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FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 25 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =1.23M, W =0.39M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.4554	-73.0	9.5	
0.4582	-73.4	9.5	158.9
0.4609	-73.6	9.6	88.7
0.4637	-73.9	9.6	84.5
0.4665	-74.2	9.9	108.2
0.4692	-74.4	9.9	98.1
0.4720	-74.6	9.8	54.8
0.4748	-74.8	10.0	81.2
0.4776	-74.9	9.8	28.7
0.4803	-75.3	10.1	171.6
0.4831	-75.4	9.8	2.4
0.4859	-75.7	9.9	127.6
0.4886	-75.7	9.9	-10.1
0.4914	-76.4	10.0	244.2
0.4942	-76.4	10.2	15.4
0.4970	-76.5	10.2	30.3
0.4997	-76.6	10.0	52.3
0.5025	-76.6	10.1	5.1
0.5053	-76.9	10.1	93.8
0.5080	-77.1	10.0	77.8
0.5108	-77.0	10.2	-25.3
0.5136	-77.5	10.0	169.0
0.5164	-78.0	10.0	169.0
0.5191	-78.2	10.3	74.4
0.5219	-78.4	10.2	62.5
0.5247	-78.5	10.3	54.9
0.5274	-78.7	10.3	64.2
0.5302	-79.0	10.3	113.2
0.5330	-79.3	10.2	91.3
0.5358	-79.3	10.4	33.8
0.5385	-79.6	10.4	102.3
0.5413	-79.7	10.3	37.2
0.5441	-79.8	10.5	40.6
0.5468	-80.0	10.3	61.7

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FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 25 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =1.23M, W =0.39M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.5496	-80.2	10.5	83.7
0.5524	-80.6	10.2	126.1
0.5552	-80.9	10.4	96.2
0.5579	-81.0	10.3	37.3
0.5607	-81.3	10.3	102.3
0.5635	-81.4	10.5	40.4
0.5662	-81.8	10.4	144.6
0.5690	-81.7	10.4	-21.1
0.5718	-82.1	10.5	127.5
0.5746	-82.4	10.4	116.8
0.5773	-82.4	10.6	14.2
0.5801	-82.6	10.7	87.8
0.5829	-83.0	10.5	134.5
0.5856	-83.3	10.4	89.8
0.5884	-83.4	10.6	26.8
0.5912	-83.6	10.6	87.9
0.5940	-83.8	10.7	83.6
0.5967	-84.2	10.6	126.9
0.5995	-84.4	10.7	89.6
0.6023	-84.5	10.6	16.2
0.6051	-84.6	10.7	47.1

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FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 26 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =1.01M, W =0.49M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.7436	-42.1	54.1	
0.7464	-42.1	54.5	114.6
0.7492	-42.4	54.7	119.3
0.7519	-42.5	55.2	158.5
0.7547	-42.4	55.9	172.0
0.7575	-42.5	55.9	9.6
0.7603	-42.5	56.6	228.0
0.7630	-42.6	56.8	58.5
0.7658	-42.6	57.2	140.4
0.7686	-42.7	57.7	156.9
0.7714	-42.8	57.8	62.8
0.7741	-42.8	58.3	121.7
0.7769	-42.9	58.6	123.1
0.7797	-43.0	59.0	130.3
0.7824	-43.1	59.1	55.9
0.7852	-43.1	59.6	147.1
0.7880	-43.0	59.9	61.1
0.7908	-43.0	60.4	139.7
0.7935	-43.0	60.8	141.0
0.7963	-43.1	61.1	96.8
0.7991	-43.1	61.4	81.8
0.8018	-43.1	61.8	109.8
0.8046	-43.2	62.4	206.2
0.8074	-43.1	62.5	22.9
0.8102	-43.1	62.9	91.3
0.8129	-43.1	63.3	119.6
0.8157	-43.0	63.6	80.2
0.8185	-43.1	64.1	179.3
0.8212	-43.0	64.6	123.9
0.8240	-43.0	64.9	87.0
0.8268	-43.0	65.2	98.3
0.8296	-43.1	65.5	90.9
0.8323	-43.0	65.9	119.5
0.8351	-43.0	66.5	178.6

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 26 2

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 26 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =1.01M, W =0.49M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.8379	-43.0	66.8	97.2
0.8406	-43.0	67.0	47.8
0.6434	-42.9	67.5	134.5
0.8462	-42.9	68.2	205.0
0.8490	-42.9	68.2	26.7
0.8517	-43.0	68.6	120.5
0.8545	-42.8	68.9	53.7
0.8573	-42.8	69.2	92.5
0.8600	-42.8	69.6	129.6
0.3628	-42.9	70.0	133.3
0.8656	-42.9	70.0	16.0
0.8684	-42.7	70.7	164.1
0.8711	-42.8	70.9	91.4
0.8739	-42.6	71.1	21.5
0.8767	-42.4	71.7	146.1
0.8794	-42.4	72.2	145.4
0.8822	-42.4	72.5	97.5
0.8850	-42.5	72.8	101.0
0.8878	-42.2	72.9	7.8
0.8905	-42.3	73.3	140.1
0.8933	-42.3	74.1	224.5
0.8961	-42.2	74.2	26.2
0.8988	-42.0	74.4	45.4
0.9016	-42.0	74.8	117.0
0.9044	-41.9	74.9	7.7
0.9072	-41.8	75.4	127.3
0.9099	-41.7	75.8	109.2
0.9127	-41.7	76.0	76.9
0.9155	-41.7	76.4	124.2
0.9182	-41.6	76.6	57.9
0.9210	-41.5	76.9	63.5
0.9238	-41.5	77.1	72.0
0.9266	-41.4	77.4	85.7
0.9293	-41.3	77.6	44.3

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FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 26 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =1.01M, W =0.49M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.9321	-41.1	77.9	57.8
0.9349	-41.2	78.3	146.0
0.9377	-41.0	78.4	-6.0
0.9404	-40.9	78.7	72.2
0.9432	-40.8	78.8	29.2
0.9460	-40.7	79.3	148.0
0.9487	-40.8	79.6	103.6
0.9515	-40.7	79.9	84.0
0.9543	-40.7	80.2	79.0
0.9571	-40.4	80.7	139.1
0.9598	-40.3	80.9	42.3
0.9626	-40.2	81.1	39.5
0.9654	-40.1	81.5	110.0
0.9681	-40.1	81.8	107.1
0.9709	-40.0	82.1	70.5
0.9737	-39.7	82.2	0.7
0.9765	-39.6	82.6	86.3
0.9792	-39.6	83.0	159.7
0.9820	-39.6	83.3	101.7
0.9848	-39.4	83.8	109.1
0.9875	-39.4	84.0	80.0
0.9903	-39.2	84.3	42.1
0.9931	-39.2	84.7	133.2
0.9959	-39.0	85.1	101.0
0.9986	-38.8	85.4	70.0
1.0014	-38.9	85.5	48.8
1.0042	-38.7	85.7	64.0
1.0069	-38.7	86.0	68.9
1.0097	-38.5	86.3	81.3
1.0125	-38.4	86.6	91.3
1.0153	-38.2	86.9	68.3
1.0180	-38.2	87.3	135.3
1.0208	-37.5	88.3	228.7
1.0236	-38.0	87.9	-65.9

PRE-DIRECT COURSE TEST, 7 OCT 1982 3365 26 4

FRAGMENT TRAJECTORY FROM CAMERA F-3365 DATA

FRAGMENT 26 CAMERA F-3365 AZIMUTH OF U-AXIS 312.1 DEG

APPARENT SIZE: L =1.01M, W =0.49M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
1.0263	-37.8	88.2	66.5
1.0291	-37.7	88.2	-3.9
1.0319	-37.7	88.2	0.0
1.0347	-37.7	88.4	51.0
1.0374	-37.7	89.3	291.7

PRE-DIRECT COURSE TEST, 7 OCT 1982 3382 1 1

FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 1 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =1.13M, W =0.24M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.0701	-23.2	62.7	
0.0728	-24.1	64.3	625.2
0.0756	-24.9	66.0	690.4
0.0839	-27.4	70.5	616.9
0.0867	-28.2	72.1	633.7
0.0894	-28.9	73.5	579.6

PRE-DIRECT COURSE TEST, 7 OCT 1982 3382 2 1

FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 2 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.29M, W =0.29M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.0922	26.3	53.8	
0.0950	27.1	55.0	500.5
0.0977	28.0	56.1	490.9
0.1005	28.8	57.2	486.4
0.1033	29.7	58.1	447.7
0.1060	30.5	59.1	460.5
0.1088	31.2	60.1	436.2
0.1116	32.0	61.1	449.0
0.1143	32.8	62.2	490.9
0.1171	33.7	63.1	431.2
0.1199	34.5	64.1	450.3
0.1226	35.2	65.1	452.0
0.1254	35.0	66.2	477.4
0.1282	36.9	67.1	459.8
0.1309	37.6	68.2	459.8
0.1337	38.5	69.4	516.5
0.1365	39.2	70.3	413.6
0.1392	40.0	71.1	407.8
0.1420	40.8	72.1	450.7
0.1448	41.5	73.0	412.3
0.1475	42.3	74.0	430.3
0.1503	43.1	75.0	475.5
0.1531	43.8	75.8	375.0
0.1559	44.6	76.9	472.6
0.1586	45.3	77.7	390.5
0.1614	46.1	78.8	490.8
0.1641	46.8	79.7	408.7
0.1669	47.4	80.7	434.1

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 4 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.50M, W =0.14M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1337	55.5	63.9	
0.1365	56.6	64.6	448.9
0.1392	57.4	65.2	375.8
0.1420	58.4	65.7	361.6
0.1448	59.2	66.3	369.8
0.1475	60.1	66.9	372.7
0.1503	61.0	67.4	324.5
0.1531	61.9	68.0	401.8
0.1558	62.8	68.7	393.0
0.1586	63.5	69.2	320.7
0.1614	64.4	69.8	382.4
0.1641	65.1	70.4	341.8
0.1669	65.8	70.9	293.7
0.1696	66.8	71.6	421.3
0.1724	67.8	72.2	425.4
0.1752	68.4	72.3	135.6
0.1779	69.2	73.0	408.4
0.1807	70.1	73.6	380.3
0.1835	70.9	73.9	277.3
0.1862	71.5	74.5	330.5
0.1890	72.5	74.8	308.7
0.1918	73.2	75.4	303.6
0.1945	73.9	75.9	326.8

PRE-DIRECT COURSE TEST, 7 OCT 1982 3382 6 1

FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 6 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.64M, W =0.14M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1475	-0.4	64.6	
0.1503	-0.3	65.4	286.5
0.1531	-0.2	66.2	303.1
0.1558	-0.4	67.2	364.8
0.1586	-0.3	68.2	353.0
0.1614	-0.4	69.2	337.1
0.1641	-0.4	70.1	331.1
0.1669	-0.3	70.9	298.0
0.1696	-0.4	72.0	409.0
0.1724	-0.4	72.9	320.4
0.1752	-0.4	73.8	314.8
0.1779	-0.5	74.7	315.4
0.1807	-0.4	75.6	337.1
0.1835	-0.4	76.5	326.0
0.1862	-0.5	77.4	337.7
0.1890	-0.4	78.2	270.6
0.1918	-0.5	79.1	354.4
0.1945	-0.6	80.0	315.8
0.1973	-0.4	81.2	414.3

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 7 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.70M, W =0.16M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1475	-5.8	70.2	
0.1503	-6.5	70.4	107.9
0.1531	-6.7	71.4	375.4
0.1558	-7.0	72.4	371.7
0.1614	-6.2	74.8	405.1
0.1641	-6.2	75.9	431.6
0.1669	-6.4	76.8	295.9
0.1696	-6.6	77.7	332.0
0.1752	-6.7	79.3	296.6
0.1807	-6.8	81.4	384.7
0.1835	-7.0	82.2	271.6

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 8 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.87M, W =0.22M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1503	-13.4	68.8	
0.1531	-13.8	69.8	402.0
0.1558	-14.3	71.8	735.1
0.1586	-14.2	71.8	3.2
0.1614	-14.4	72.7	335.1
0.1669	-15.0	74.4	306.6
0.1696	-15.2	75.2	324.5
0.1724	-15.3	76.4	438.3
0.1752	-15.6	77.1	261.8
0.1779	-15.7	78.0	305.1
0.1807	-15.9	78.7	260.6
0.1835	-16.2	79.4	299.0
0.1862	-16.4	80.4	364.9

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 9 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.66M, W =0.13M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1558	25.7	63.7	
0.1586	26.2	64.5	333.4
0.1614	26.7	65.2	286.5
0.1641	27.2	66.1	371.6
0.1669	27.6	66.8	284.6
0.1696	28.1	67.5	324.3
0.1724	28.6	68.3	320.1
0.1752	28.9	68.8	224.6
0.1779	29.5	69.7	357.1
0.1807	29.8	70.3	272.8
0.1835	30.3	71.0	300.0
0.1862	30.7	71.9	343.8
0.1890	31.2	72.4	230.0
0.1918	31.6	73.2	339.8
0.1945	32.1	73.9	285.4
0.1973	32.5	74.5	262.4
0.2001	32.9	75.4	343.7
0.2028	33.3	76.1	312.5
0.2056	33.7	76.8	295.2
0.2084	34.1	77.4	236.6
0.2111	34.5	78.0	272.9
0.2139	34.9	78.8	303.4
0.2167	35.5	79.5	314.1
0.2194	35.9	79.8	188.7
0.2222	36.2	80.5	272.2
0.2250	36.5	81.3	310.3
0.2277	37.2	82.1	350.8

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 11 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.42M, W =0.44M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1614	62.3	10.0	
0.1641	62.9	10.2	215.6
0.1669	63.3	10.2	133.8
0.1696	63.8	10.4	206.6
0.1724	64.3	10.5	262.3
0.1752	64.8	10.6	114.1
0.1779	65.3	10.7	157.2
0.1807	65.8	11.0	194.4
0.1835	66.3	11.0	180.4
0.1862	66.7	11.3	176.5
0.1890	67.2	11.3	174.1
0.1918	67.7	11.4	176.3
0.1945	68.2	11.5	197.5
0.1973	68.7	11.8	205.0
0.2001	69.2	12.1	172.5
0.2028	69.6	12.1	160.3
0.2056	70.2	12.4	206.3
0.2084	70.6	12.3	151.9
0.2111	71.1	12.5	179.4
0.2139	71.5	12.8	189.9
0.2167	72.0	12.9	178.6
0.2194	72.6	12.8	208.9
0.2222	73.4	12.7	262.3
0.2250	74.2	12.5	273.5
0.2277	74.1	13.5	19.9
0.2305	74.6	13.4	185.2
0.2333	75.0	13.5	129.6
0.2360	75.4	13.6	158.5
0.2388	75.9	13.6	190.0
0.2416	76.4	13.8	192.8
0.2443	76.8	13.9	124.3
0.2471	77.1	14.3	159.8
0.2499	77.5	14.4	175.7
0.2526	78.1	14.6	191.9

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 12 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.39M, W =0.39M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.2554	75.8	16.2	141.7
0.2582	76.3	16.4	218.9
0.2609	75.7	16.7	135.4
0.2637	77.0	16.9	122.4
0.2665	77.4	17.0	175.0
0.2692	77.3	17.4	170.5
0.2720	78.2	17.4	136.9
0.2748	78.7	17.5	182.0

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 13 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.45M, W =0.42M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1614	59.6	11.5	
0.1641	60.0	11.8	183.3
0.1669	60.3	12.0	113.9
0.1696	60.7	12.2	148.2
0.1724	61.2	12.6	218.7
0.1752	61.5	12.7	103.0
0.1779	61.9	12.9	164.5
0.1807	62.3	13.1	164.6
0.1835	62.6	13.3	119.6
0.1862	63.0	13.4	155.8
0.1890	63.6	13.7	203.9
0.1918	63.8	13.9	107.4
0.1945	64.1	14.2	133.7
0.1973	64.6	14.4	174.1
0.2001	64.8	14.8	120.3
0.2028	65.2	15.0	157.2
0.2056	65.7	15.4	208.6
0.2084	66.1	15.3	113.1
0.2111	66.3	15.6	116.2
0.2139	66.8	15.9	181.3
0.2167	67.2	16.2	181.5
0.2194	67.6	16.3	132.6
0.2222	67.9	16.4	129.9
0.2250	68.3	16.7	157.9
0.2277	68.7	17.0	151.4
0.2305	69.0	17.3	137.3
0.2333	69.4	17.4	153.9
0.2360	69.8	17.8	161.3
0.2388	70.1	17.8	123.3
0.2416	70.5	18.1	153.5
0.2443	70.9	18.3	176.8
0.2471	71.9	18.8	391.6
0.2499	71.6	18.8	-125.7
0.2526	71.9	19.0	154.9

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 13 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.45M, W =0.42M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.2554	72.3	19.3	140.7
0.2582	72.7	19.5	181.5
0.2609	72.9	19.9	101.5
0.2637	73.2	20.1	102.1
0.2665	73.7	20.4	235.9
0.2692	75.0	20.5	435.0
0.2720	75.6	20.9	258.4
0.2748	75.7	21.0	36.1
0.2775	75.6	21.1	0.1
0.2803	75.7	21.1	24.8

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 14 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.21M, W =0.18M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1696	26.1	56.2	
0.1724	26.6	56.9	325.1
0.1752	26.6	57.4	179.0
0.1779	27.3	58.1	311.6
0.1807	27.8	58.8	296.3
0.1835	28.2	59.3	227.0
0.1862	28.7	59.9	284.3
0.1890	29.1	60.5	247.3
0.1918	29.5	61.2	299.8
0.1945	30.0	61.7	252.3
0.1973	30.5	62.4	309.5
0.2001	30.8	63.1	276.0
0.2028	31.3	63.7	272.4
0.2056	31.8	64.4	297.4
0.2084	32.2	64.8	194.1
0.2111	32.6	65.5	285.5
0.2139	33.1	66.3	332.4
0.2167	33.6	66.9	283.0
0.2194	34.1	67.3	209.3
0.2222	34.5	67.9	258.8
0.2250	34.9	68.6	308.2
0.2277	35.4	69.3	303.3
0.2305	35.9	69.8	244.4
0.2333	36.3	70.4	259.2
0.2360	36.7	71.1	261.5
0.2388	37.2	71.7	291.6
0.2416	37.6	72.3	256.9
0.2443	38.1	72.9	292.0
0.2471	38.5	73.5	249.5
0.2499	38.9	74.1	242.4
0.2526	39.3	74.7	269.5
0.2554	39.8	75.4	326.6
0.2582	40.3	76.1	279.6
0.2609	40.7	76.7	259.9

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 14 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.21M, W =0.18M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.2637	41.0	77.4	281.7
0.2665	41.7	78.1	349.7
0.2692	42.2	79.0	351.3
0.2720	42.6	79.4	211.3

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA
FRAGMENT 15 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG
APPARENT SIZE: L =0.64M, W =0.16M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1918	63.3	20.7	
0.1945	63.8	21.0	225.0
0.1973	64.2	21.4	157.9
0.2001	64.4	21.7	114.8
0.2028	64.7	21.9	116.3
0.2056	65.1	22.2	194.8
0.2084	65.5	22.1	108.1
0.2111	65.7	22.5	101.6
0.2139	66.0	23.0	185.9
0.2167	66.5	23.2	173.4
0.2194	66.7	23.1	82.1
0.2222	67.1	23.5	174.9
0.2250	67.2	23.5	27.6
0.2277	67.6	24.0	186.4
0.2305	68.0	24.3	182.9
0.2333	68.3	24.4	110.0
0.2360	68.5	24.7	121.4
0.2388	68.8	24.8	94.9
0.2416	69.1	25.1	168.9
0.2443	69.5	25.3	124.9
0.2471	69.6	25.4	67.2
0.2499	69.9	25.6	116.6
0.2526	70.2	26.0	164.9
0.2554	70.3	26.6	102.0

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 19 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.82M, W =0.14M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.2443	66.4	18.2	
0.2471	66.8	18.2	109.1
0.2499	67.1	18.4	138.9
0.2526	67.2	18.5	60.0
0.2554	67.5	18.8	122.4
0.2582	67.9	18.9	139.7
0.2609	68.4	19.1	199.9
0.2637	68.6	19.3	79.7
0.2665	69.2	19.4	213.3
0.2692	69.4	19.5	77.4
0.2720	69.7	19.6	126.2
0.2748	70.2	20.0	228.3
0.2775	70.0	20.0	-84.9
0.2803	70.1	20.1	40.2
0.2830	70.5	20.2	166.1
0.2858	70.9	20.2	152.2
0.2886	71.2	20.5	95.1
0.2913	71.5	20.6	121.0
0.2941	71.8	20.9	127.2
0.2969	71.9	20.3	44.0
0.2996	72.3	21.1	173.5
0.3024	72.3	21.0	-6.3
0.3052	72.8	21.4	186.7
0.3079	73.0	21.3	84.3
0.3107	73.4	21.2	116.4
0.3135	72.9	21.2	-176.1
0.3162	73.9	21.4	365.8
0.3190	74.0	21.6	72.9
0.3218	74.5	21.9	194.1
0.3245	74.6	21.9	27.8
0.3273	74.9	22.1	115.9
0.3301	75.0	22.0	59.7
0.3328	75.3	22.4	118.8
0.3356	75.4	22.2	36.0

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 19 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.82M, W =0.14M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.3384	75.9	22.6	179.7
0.3411	76.0	22.7	77.7
0.3439	76.5	22.7	144.5
0.3467	76.5	22.7	15.3
0.3494	76.8	23.0	126.4
0.3522	76.9	23.1	45.1
0.3550	77.1	23.2	86.2
0.3577	77.7	23.4	226.6
0.3605	77.8	23.4	43.8
0.3633	78.2	23.9	195.0
0.3660	78.4	23.8	58.0
0.3688	78.6	23.6	51.9
0.3716	78.6	24.1	62.6
0.3743	79.0	24.2	133.8
0.3771	79.2	24.2	64.3
0.3799	79.4	24.3	86.0
0.3826	79.3	24.4	154.7

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 20 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.95M, W =0.32M ROTATING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.2803	2.7	68.7	
0.2830	2.6	69.2	169.9
0.2858	2.8	69.6	140.5
0.2886	2.8	70.0	159.6
0.2913	2.7	70.5	181.3
0.2941	2.7	71.2	235.4
0.2969	2.8	71.5	123.4
0.2996	2.9	72.0	161.4
0.3024	2.8	72.4	164.3
0.3052	2.8	72.9	181.5
0.3079	3.0	73.3	140.7
0.3107	3.2	73.6	113.5
0.3135	3.1	74.3	246.4
0.3162	3.0	74.7	143.2
0.3190	3.1	75.1	150.3
0.3218	3.3	75.6	184.3
0.3245	3.2	76.1	159.0
0.3273	3.0	76.9	296.2
0.3301	3.2	77.0	36.1
0.3328	3.3	77.4	155.7
0.3356	3.3	78.0	214.9
0.3384	3.3	78.3	94.0
0.3411	3.3	78.7	171.5
0.3439	3.4	79.1	122.6
0.3467	3.4	79.7	215.4
0.3494	3.4	80.1	160.5
0.3522	3.4	80.3	77.2
0.3550	3.5	80.9	223.0
0.3577	3.6	81.6	233.5
0.3605	3.6	82.1	188.5
0.3633	3.6	82.6	187.2
0.3660	3.6	82.9	100.4

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 21 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.63M, W =0.23M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.3079	66.1	34.0	
0.3107	66.3	34.0	56.2
0.3135	66.4	34.2	74.0
0.3162	66.4	34.4	8.9
0.3190	66.4	34.6	53.0
0.3218	66.6	34.9	99.6
0.3245	66.6	35.0	33.3
0.3273	66.6	35.3	48.6
0.3301	66.7	35.4	67.3
0.3328	67.0	35.7	109.3
0.3356	67.0	36.0	64.3
0.3384	66.8	35.9	-58.2
0.3411	67.1	36.3	147.2
0.3439	67.2	36.3	24.0
0.3467	67.2	36.5	32.3
0.3494	67.3	36.7	62.8
0.3522	67.2	36.8	12.3
0.3550	67.4	36.9	73.5
0.3577	67.5	37.3	82.0
0.3605	67.6	37.6	103.2
0.3633	67.8	37.7	89.1
0.3660	67.8	37.9	16.1
0.3688	68.0	38.0	70.1
0.3771	68.1	38.6	50.5
0.3799	68.1	38.8	39.7
0.3826	68.2	38.9	25.3
0.3854	68.1	39.0	11.3
0.3882	68.2	39.1	59.1
0.3909	68.5	39.4	120.9
0.3937	68.9	39.7	172.2
0.3964	68.6	39.7	-67.3
0.3992	68.7	40.0	54.1
0.4020	68.7	40.2	53.7
0.4047	68.7	40.3	12.2

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 21 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.63M, W =0.23M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.4075	68.9	40.4	77.2
0.4103	68.9	40.4	1.9
0.4130	69.0	40.7	76.2
0.4158	69.0	40.7	9.4
0.4186	69.2	41.0	106.5
0.4213	69.2	41.2	43.6
0.4241	69.4	41.2	54.3
0.4269	69.0	41.4	-65.1
0.4296	69.3	41.8	155.9
0.4324	69.1	41.8	-51.4
0.4352	69.2	42.0	77.0
0.4379	69.4	42.0	34.5
0.4407	69.4	42.1	26.7
0.4435	69.4	42.3	39.4
0.4462	69.4	42.4	26.1
0.4490	69.5	42.5	33.1
0.4518	69.4	42.7	18.0
0.4545	69.6	43.0	89.7
0.4573	69.6	43.0	36.1
0.4601	69.6	42.9	-39.1
0.4628	69.7	43.3	107.5
0.4656	69.7	43.4	14.7
0.4684	69.7	43.6	42.9
0.4711	69.8	43.7	40.9
0.4739	70.1	44.0	153.0
0.4767	69.9	44.0	-55.5
0.4794	70.0	44.3	98.0
0.4822	70.1	44.2	23.4
0.4850	70.1	44.4	29.4
0.4877	70.2	44.3	14.5
0.4905	69.9	44.4	-83.4
0.4933	70.0	44.6	89.3
0.4960	70.2	44.9	98.3
0.4988	70.2	45.0	13.5

PRE-DIRECT COURSE TEST, 7 OCT 1982 3382 21 3

FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 21 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.63M, W =0.23M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.5015	70.3	45.0	23.0
0.5043	70.3	45.1	40.6
0.5071	70.3	45.1	13.8
0.5098	70.5	45.3	98.9
0.5126	70.4	45.3	-53.4
0.5154	70.6	45.5	98.7
0.5181	70.6	45.7	40.9
0.5209	70.7	46.0	106.3
0.5237	70.7	45.9	-47.2
0.5264	70.7	46.2	65.4
0.5292	70.9	46.2	73.1
0.5320	70.9	46.5	56.3
0.5347	70.9	46.8	62.7
0.5375	70.9	46.7	-13.8
0.5403	71.1	46.7	68.5
0.5430	71.1	46.6	-39.6
0.5458	71.2	46.8	54.9
0.5486	71.0	46.6	-93.0
0.5513	71.0	47.1	107.2
0.5541	71.2	47.2	86.8
0.5569	71.1	47.2	-25.8
0.5596	71.2	46.9	-37.0
0.5624	71.3	47.2	38.8
0.5652	71.2	47.0	-56.7
0.5679	71.1	47.0	-38.0
0.5707	71.3	47.8	211.8
0.5735	71.3	47.5	-60.2
0.5762	71.4	48.0	132.5
0.5790	71.5	48.2	71.9
0.5818	71.5	48.2	10.7
0.5845	71.4	48.2	-27.2
0.5873	71.6	48.3	53.5
0.5901	71.7	48.5	75.7
0.5928	71.6	48.3	35.8

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 21 — CAMERA F-3382 — AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.63M, W =0.23M — TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.5956	71.7	48.9	56.3
0.5984	71.8	49.0	66.1
0.6011	71.7	49.0	-50.0
0.6039	71.8	49.2	76.9
0.6067	71.8	49.2	-4.5
0.6094	71.8	49.3	8.5
0.6122	71.9	49.3	31.5
0.6149	71.8	49.4	10.3
0.6177	71.9	49.4	34.7
0.6205	71.9	49.4	0.0
0.6232	72.1	49.9	138.0
0.6260	72.3	50.0	77.9
0.6288	72.1	50.0	-53.4
0.6315	72.2	50.1	45.4
0.6343	72.2	50.4	62.3
0.6371	72.2	50.4	-0.6
0.6398	72.3	50.5	51.9
0.6426	72.3	50.3	-50.9
0.6454	72.3	50.4	6.9
0.6481	72.6	50.3	87.9
0.6509	72.5	50.7	41.8
0.6537	72.5	50.9	46.7
0.6564	72.5	50.9	25.6
0.6592	73.0	50.7	80.2
0.6620	72.8	51.0	9.9
0.6647	72.7	51.2	5.8
0.6675	72.6	51.2	-14.0
0.6703	72.8	51.4	92.7
0.6730	72.6	51.4	-53.6
0.6758	72.9	51.4	82.3
0.6786	72.8	51.5	-17.7
0.6813	73.0	51.6	75.3
0.6841	72.9	51.5	-15.4
0.6896	73.1	51.7	43.2

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 21 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.63M, W =0.23M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.6924	72.9	52.0	-10.0
0.6952	74.1	52.2	401.7
0.6979	73.1	52.2	-282.8
0.7007	74.0	52.2	277.1
0.7035	74.2	52.4	86.4
0.7062	74.1	52.4	-35.2
0.7090	73.2	52.4	-270.5
0.7118	73.9	52.5	237.0
0.7145	74.0	52.1	-49.2
0.7173	73.4	52.7	-79.8
0.7201	73.4	52.9	43.5
0.7228	74.5	52.7	281.4
0.7256	73.7	52.1	-344.1
0.7283	73.7	53.3	241.6
0.7311	73.8	53.3	23.1
0.7339	74.7	53.7	371.7
0.7366	74.1	53.8	-185.2
0.7394	73.8	53.5	-146.2
0.7422	74.6	52.5	39.4
0.7449	74.2	52.0	-217.5
0.7477	74.1	51.8	-77.4
0.7505	74.2	52.1	78.0
0.7532	74.0	52.2	-21.6
0.7560	73.9	52.1	-56.9
0.7588	74.0	52.0	29.9
0.7615	74.2	52.0	39.6
0.7643	74.1	52.0	-16.6
0.7671	74.1	52.0	-9.6
0.7698	74.0	52.3	47.5
0.7726	74.0	52.2	-17.3
0.7754	74.0	52.4	41.8
0.7781	74.1	52.3	-16.8
0.7809	74.1	52.2	-6.4
0.7837	74.1	52.2	3.8

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 21 CAMERA F-3332 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.63M, W =0.23M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.7864	74.2	52.5	66.7
0.7892	74.0	52.1	-117.3

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 23 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.46M, W =0.24M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.4324	75.4	31.2	
0.4352	75.6	31.4	84.9
0.4379	75.8	31.4	76.3
0.4407	75.8	31.4	-23.7
0.4435	75.9	31.6	86.3
0.4462	76.1	31.7	69.0
0.4490	76.2	32.0	84.9
0.4518	76.3	32.1	27.4
0.4545	76.4	32.1	52.5
0.4573	76.5	32.2	41.0
0.4601	76.5	32.2	-2.2
0.4628	76.9	32.6	178.8
0.4656	76.7	32.9	3.7
0.4684	76.7	32.8	-35.5
0.4711	77.0	33.0	126.8
0.4739	77.2	33.1	104.6
0.4767	77.2	33.3	19.3
0.4794	77.3	33.4	56.2
0.4822	77.4	33.5	21.1
0.4850	77.4	33.5	31.2
0.4877	77.4	33.6	-0.6
0.4905	77.0	33.5	-143.6
0.4933	77.1	33.9	80.5
0.4960	77.7	34.2	251.8
0.4988	77.9	34.7	147.4
0.5015	78.0	34.5	5.4
0.5043	78.0	34.6	8.1
0.5071	78.1	34.7	58.6
0.5098	78.4	34.8	90.5
0.5126	78.2	34.9	-36.2
0.5154	78.5	35.0	110.7
0.5181	78.6	35.2	60.0
0.5209	78.6	35.4	27.1
0.5237	78.7	35.6	47.9

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 23 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.46M, W =0.24M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.5264	78.7	35.5	5.4
0.5292	78.8	35.7	57.9
0.5320	79.0	36.0	93.7
0.5347	78.9	36.1	-15.9
0.5375	79.1	36.1	79.5
0.5403	79.2	36.2	67.6
0.5430	79.2	36.2	-7.3
0.5458	79.4	36.2	57.0
0.5486	79.5	36.5	71.7
0.5513	79.5	36.7	18.2
0.5541	79.6	36.8	44.1
0.5569	79.7	37.0	77.5
0.5596	79.7	36.7	-32.6
0.5624	79.8	37.1	76.0
0.5652	79.9	37.3	65.2
0.6620	77.4	41.6	-3.5
~~0.8417~~	~~55.7~~	~~57.1~~	~~44.9~~
1.0105	77.5	41.8	~~49.2~~

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 25 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.54M, W =0.11M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.4905	67.0	32.4	
0.4933	67.1	32.6	61.0
0.4960	67.2	32.6	36.8
0.4988	67.2	32.8	44.0
0.5015	67.3	32.8	24.5
0.5043	67.4	32.9	56.3
0.5071	67.6	32.9	58.9
0.5098	67.6	32.8	-17.0
0.5126	67.7	33.0	85.6
0.5154	67.8	33.3	44.1
0.5181	67.8	33.3	17.2
0.5209	67.9	33.6	86.0
0.5237	68.6	34.1	294.5
0.5264	68.1	33.6	-250.4
0.5292	68.3	33.6	73.5
0.5320	68.4	34.2	147.9
0.5347	68.4	34.2	-9.7
0.5375	68.5	34.1	-0.4
0.5403	68.6	34.1	56.4
0.5430	68.6	34.1	-27.1
0.5458	68.5	34.2	-4.6
0.5486	68.6	34.2	19.5
0.5513	68.7	34.2	51.4
0.5541	68.8	34.4	54.4
0.5569	69.0	34.4	73.3
0.5596	69.3	34.5	127.4
0.5624	69.0	34.5	-105.3
0.5652	69.3	34.7	122.9
0.5679	69.1	34.7	-51.3
0.5707	69.3	34.8	78.7
0.5735	69.2	34.7	-37.0
0.5762	69.5	34.9	93.3
0.5790	69.4	34.9	-12.1
0.5818	69.6	35.0	63.8

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 25 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.54M, W =0.11M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.5845	69.5	35.0	-9.8
0.5873	69.7	35.1	73.7
0.5901	69.8	35.2	56.7
0.5928	69.6	35.2	-53.6
0.5956	69.9	35.5	118.6
0.5984	70.0	35.5	45.5
0.6011	70.0	35.3	-15.4
0.6039	69.8	35.5	-32.9
0.6067	69.8	35.8	38.0
0.6094	69.8	35.7	-9.9
0.6122	70.1	35.8	100.0
0.6149	70.1	35.7	-27.4
0.6177	69.9	35.7	-48.7
0.6205	70.1	35.8	59.2
0.6232	70.2	36.0	86.5
0.6260	70.3	35.9	14.2
0.6288	70.2	35.9	-24.7
0.6315	70.3	36.4	108.9
0.6343	70.2	36.6	6.3
0.6371	70.3	36.8	65.1
0.6398	70.2	36.8	-41.3
0.6426	70.4	36.6	14.6
0.6454	70.7	37.1	172.2
0.6481	70.8	36.7	-16.0
0.6509	71.2	37.3	221.5
0.6537	71.1	37.3	-19.0
0.6564	71.4	37.5	118.1
0.6592	71.4	37.0	-79.6
0.6620	71.3	36.8	-65.5
0.6647	71.3	36.9	25.3
0.6675	71.4	36.9	24.0
0.6703	71.5	37.1	72.4
0.6730	71.6	36.9	-21.3
0.6758	71.6	36.9	14.6

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FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 25 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.54M, W =0.11M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.6786	71.6	37.0	15.3
0.6813	71.7	37.0	32.2
0.6841	71.8	37.1	56.2
0.6869	71.8	37.2	22.5
0.6896	71.8	37.3	5.7
0.6924	71.9	37.4	54.5
0.6952	72.0	37.4	20.0
0.6979	72.0	37.4	29.1
0.7007	72.1	37.5	14.8
0.7035	72.2	37.6	61.6
0.7062	72.2	37.6	-12.3
0.7090	72.3	37.6	56.2
0.7118	72.4	37.8	43.2
0.7145	72.3	37.9	3.2
0.7173	72.5	37.8	35.5
0.7201	72.4	37.7	-47.1
0.7228	72.4	38.1	76.5
0.7256	72.6	38.1	62.9
0.7283	72.7	38.1	39.7
0.7311	72.8	38.1	11.9
0.7339	72.7	38.2	1.0
0.7366	72.8	38.3	49.8
0.7394	72.8	38.3	-10.0
0.7422	72.7	38.6	3.8
0.7449	72.5	38.1	-143.9
0.7477	73.0	37.9	121.0
0.7505	72.8	38.2	-6.5
0.7532	72.9	38.3	59.4
0.7560	73.2	38.6	133.7
0.7588	72.8	38.0	-202.2
0.7615	73.4	38.9	326.8
0.7643	73.3	38.9	-19.3
0.7671	73.4	38.8	8.1
0.7698	73.5	38.8	12.3

PRE-DIRECT COURSE TEST, 7 OCT 1982
FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA
FRAGMENT 25 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG
APPARENT SIZE: L =0.54M, W =0.11M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.7726	73.5	38.8	9.7
0.7754	73.5	38.8	17.1
0.7781	73.6	39.0	33.5
0.7809	73.8	39.0	62.8
0.7837	73.8	39.0	27.5
0.7864	73.7	39.0	-24.1
0.7892	73.8	39.0	31.6
0.7920	73.9	39.2	38.4
0.7947	74.0	39.2	33.8
0.7975	73.8	39.3	-37.4
0.8003	74.1	39.5	110.8
0.8030	74.2	39.3	10.2
0.8058	74.2	39.3	9.7
0.8086	74.2	39.4	0.4
0.8113	74.2	39.4	0.4
0.8141	74.3	39.6	72.2
0.8169	74.3	39.5	4.0
0.8196	74.4	39.5	24.5
0.8224	73.7	39.7	-201.8
0.8252	74.5	39.6	236.4
0.8279	74.5	39.6	12.3
0.8307	74.7	39.6	45.6
0.8334	74.6	39.6	-31.6
0.8362	74.1	40.0	-78.3
0.8390	74.6	39.6	73.5
0.8417	74.9	39.7	117.4
0.8445	74.9	39.6	4.0
0.8473	74.8	39.7	-16.3
0.8500	75.2	39.7	108.8
0.8528	75.2	39.7	12.3
0.8556	75.1	39.7	-21.5
0.8583	75.2	39.9	45.4
0.8611	75.2	40.0	20.9
0.8639	75.1	39.5	-117.3

PRE-DIRECT COURSE TEST, 7 OCT 1982 3382 25 5
FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA
FRAGMENT 25 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG
APPARENT SIZE: L =0.54M, W =0.11M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.8666	75.3	40.1	159.3
0.8694	75.2	40.2	1.3
0.8722	75.3	40.1	5.7
0.8749	75.3	40.1	17.1
0.8777	75.4	40.0	9.2
0.8805	75.5	40.2	47.7
0.8832	75.5	40.1	1.8
0.8860	75.5	40.2	3.0
0.8888	75.5	40.4	46.4
0.8915	75.6	40.5	35.1
0.8943	75.7	40.4	28.5
0.8971	75.8	40.5	37.2
0.8998	75.8	40.5	-5.7
0.9026	75.8	40.4	16.2
0.9054	75.8	40.5	-13.6
0.9081	75.8	40.5	19.7
0.9109	75.8	40.5	-12.3
0.9137	76.1	40.7	115.7
0.9164	76.1	40.7	12.3
0.9192	76.1	40.8	6.2
0.9220	76.1	40.9	30.3
0.9247	76.2	40.8	30.6
0.9275	76.3	41.0	43.5
0.9303	76.2	41.0	-11.3
0.9330	76.4	41.0	55.1
0.9358	76.3	41.1	-11.3
0.9386	76.5	40.9	4.3
0.9413	76.5	40.9	13.2
0.9441	76.5	40.9	12.3
0.9468	76.6	41.0	29.4
0.9496	76.4	41.0	-25.3
0.9524	76.5	41.0	14.4
0.9551	76.6	41.2	55.3
0.9579	76.8	41.3	71.4

PRE-DIRECT COURSE TEST, 7 OCT 1982 3382 25 6

FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 25 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.54M, W =0.11M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.9607	76.9	41.3	31.0
0.9634	76.7	41.1	-74.5
0.9662	76.9	41.2	78.0
0.9690	77.2	41.5	137.3
0.9717	77.6	41.8	177.0
0.9745	76.9	42.0	-168.3
0.9773	77.1	41.7	10.7
0.9800	77.1	41.6	-42.6
0.9828	77.1	41.5	-6.3
0.9856	77.3	41.5	58.2
0.9939	77.3	41.7	9.7
0.9966	77.3	41.7	24.5
0.9994	77.4	41.6	0.7
1.0022	77.4	41.6	10.1
1.0049	77.4	41.8	20.0
1.0077	77.5	41.8	27.9
1.0105	77.5	41.7	8.7
1.0132	77.5	41.9	26.5
1.0160	77.4	41.8	-71.4
1.0188	77.6	41.9	103.4
1.0215	77.7	41.8	8.6
1.0243	77.7	42.1	46.7
1.0271	77.8	41.9	2.3
1.0298	77.7	41.9	-21.4
1.0326	77.8	42.0	41.6
1.0354	78.0	41.9	33.2
1.0381	77.9	41.9	-9.6
1.0409	77.9	42.0	5.8
1.0437	77.8	41.8	-75.1
1.0464	77.7	41.8	-9.6
1.0492	78.0	41.7	48.9
1.0520	77.7	41.8	-51.1
1.0547	78.0	42.1	122.0
1.0575	77.9	42.2	12.1

PRE-DIRECT COURSE TEST, 7 OCT 1982
FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA
FRAGMENT 25 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG
APPARENT SIZE: L =0.54M, W =0.11M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
1.0602	78.0	42.4	59.7
1.0630	78.2	42.2	19.3
1.0658	78.3	42.0	13.7
1.0685	78.5	42.0	53.0
1.0713	78.4	42.0	-24.1
1.0741	78.6	42.2	89.9
1.0768	78.9	42.4	142.9
1.0796	78.8	42.3	-59.7
1.0824	78.6	42.3	-82.3
1.0851	78.8	42.3	80.1
1.0879	78.9	42.1	-20.7
1.0907	78.9	42.4	66.7
1.0934	78.7	42.6	-39.9
1.0962	78.8	42.8	58.6
1.0990	78.9	42.8	36.8
1.1017	78.9	42.6	-28.1
1.1045	78.8	42.6	-8.6
1.1073	78.9	42.5	7.2
1.1100	78.9	42.6	13.7
1.1128	79.2	42.9	143.9
1.1156	79.1	42.7	-58.0
1.1183	79.1	42.7	-2.6
1.1211	79.1	42.9	27.6
1.1239	79.2	43.0	38.4
1.1266	79.1	43.0	-20.3
1.1294	79.2	42.9	9.1
1.1322	79.2	43.2	49.5
1.1349	79.1	43.1	-32.5
1.1377	79.3	43.0	22.4
1.1405	79.3	42.8	-2.6
1.1432	79.6	42.8	86.1
1.1460	79.5	42.7	-54.4
1.1488	79.5	42.7	-20.2
1.1515	79.4	42.6	-39.5

PRE-DIRECT COURSE TEST, 7 OCT 1982 3382 25 8

FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 25 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.54M, W =0.11M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
1.1543	79.5	42.5	7.8
1.1571	79.5	42.6	33.4
1.1598	79.7	42.5	37.2
1.1626	79.6	42.4	-35.9
1.1653	79.7	42.2	-11.3
1.1681	79.7	42.2	-10.9
1.1709	79.7	42.2	-9.7
1.1736	79.9	42.1	69.9
1.1764	79.9	42.0	-31.2
1.1792	79.8	42.0	-33.5
1.1819	79.8	42.1	37.2
1.1847	79.9	42.0	18.6
1.1875	79.9	41.7	-59.3
1.1902	79.9	41.5	-23.2
1.1930	80.0	41.5	8.8
1.1958	80.2	41.6	75.2
1.1985	80.3	41.4	5.7
1.2013	80.1	41.3	-59.3

PRE-DIRECT COURSE TEST, 7 OCT 1982 3382 27 1

FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 27 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =1.37M, W =0.26M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.9773	57.9	36.8	
0.9800	58.1	36.7	22.4
0.9828	58.0	36.7	-23.1
0.9856	58.1	36.7	33.3
0.9883	57.9	37.0	3.1
0.9911	57.9	37.0	13.6
0.9939	57.8	37.0	-39.8
0.9966	57.8	37.1	17.9
0.9994	57.9	36.9	-26.7
1.0022	57.8	37.0	14.7
1.0049	57.8	37.1	2.8
1.0077	57.8	37.2	40.7
1.0105	57.9	37.1	-11.8
1.0132	57.7	37.2	-52.3
1.0160	57.7	37.2	13.6
1.0188	57.6	37.2	-13.8
1.0215	57.5	37.3	-44.4
1.0243	57.5	37.3	27.4
1.0271	57.6	37.4	31.8
1.0298	57.6	37.6	51.6
1.0326	57.6	37.5	-13.6
1.0354	57.5	37.5	-54.8
1.0381	57.4	37.4	-31.9
1.0409	57.3	37.5	-21.4
1.0437	57.1	37.3	-74.5
1.0464	57.2	37.4	27.3
1.0492	57.4	37.6	83.6
1.0520	57.5	37.7	86.7
1.0547	57.3	37.8	-45.6
1.0575	57.2	37.8	-45.5
1.0602	57.3	37.8	44.0
1.0630	56.9	37.6	-158.1
1.0658	56.8	37.6	-44.1
1.0685	56.9	37.6	42.5

PRE-DIRECT COURSE TEST, 7 OCT 1982
FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA
FRAGMENT 27 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG
APPARENT SIZE: L =1.37M, W =0.26M TUMBLING

TIME (SEC)	J (M)	Z (M)	VELOCITY (M/SEC)
1.0713	57.2	37.7	104.9
1.0741	57.5	38.0	144.5
1.0768	57.6	38.0	18.2
1.0796	57.1	38.0	-131.9
1.0824	57.1	38.0	-19.8
1.0851	56.7	38.0	-119.5
1.0879	56.7	38.0	18.1
1.0907	56.7	38.1	20.0
1.0934	57.0	38.2	107.7
1.0962	57.0	38.1	-38.1
1.0990	57.0	38.2	29.0
1.1017	56.7	38.3	-74.9
1.1045	56.8	38.1	11.2
1.1073	56.4	38.2	-123.4
1.1100	56.4	38.3	42.9
1.1128	56.6	38.4	79.1
1.1156	56.9	38.5	124.3
1.1183	56.4	38.5	-171.8
1.1211	56.5	38.6	30.5
1.1239	56.4	38.7	25.8
1.1266	56.5	38.7	31.5
1.1294	55.0	38.6	-186.6
1.1322	56.0	38.7	1.8
1.1349	56.2	38.7	78.2
1.1377	56.6	38.7	133.7
1.1405	55.8	38.6	-263.5
1.1432	56.1	38.6	83.6
1.1460	56.2	38.6	47.2
1.1488	55.9	38.6	-102.5
1.1515	56.2	38.5	70.2
1.1543	55.5	38.5	-221.1
1.1571	55.4	38.4	-30.1
1.1598	55.8	38.3	82.2
1.1626	55.5	38.2	-104.3

PRE-DIRECT COURSE TEST, 7 OCT 1982
FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA
FRAGMENT 27 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG
APPARENT SIZE: L =1.37M, W =0.26M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
1.1653	55.7	38.1	28.0
1.1681	55.7	38.2	21.5
1.1709	55.3	37.7	-219.9
1.1736	55.7	38.0	176.5
1.1764	55.8	38.0	29.8
1.1792	55.6	38.0	-38.8
1.1819	55.2	37.8	-178.9
1.1847	55.4	37.8	58.6
1.1875	55.4	37.7	-15.9
1.1902	55.7	37.6	72.0
1.1930	56.0	37.7	96.7
1.1958	55.6	37.6	-113.4
1.1985	55.7	37.7	33.6
1.2013	55.5	37.6	-74.3
1.2041	54.7	37.7	-218.7
1.2068	55.0	37.8	109.2
1.2096	54.8	37.8	-53.0
1.2124	55.0	37.9	79.1
1.2151	55.0	37.9	-16.6
1.2179	54.9	38.0	11.7
1.2207	54.9	38.0	-16.1
1.2234	54.9	38.0	4.5
1.2262	54.6	38.0	-100.4
1.2290	54.8	38.1	95.6
1.2317	54.7	38.2	-19.2
1.2345	54.8	38.4	83.9
1.2373	55.0	38.5	81.6
1.2400	55.3	38.9	156.7
1.2428	54.7	39.0	-158.2
1.2456	54.9	39.4	147.1
1.2483	54.5	39.5	-111.0
1.2511	54.5	39.7	76.2
1.2539	54.4	39.8	-32.0
1.2566	54.5	39.8	36.2

PRE-DIRECT COURSE TEST, 7 OCT 1982 3332 27 4

FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 27 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =1.37M, W =0.26M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
1.2594	54.8	39.9	95.7
1.2622	54.9	39.9	46.2
1.2649	54.8	39.9	-53.9
1.2677	54.4	39.6	-150.3
1.2705	54.4	39.7	18.6
1.2732	54.3	39.6	-42.8
1.2760	54.4	39.8	59.1
1.2787	54.5	39.8	8.8
1.2815	54.5	40.0	56.7
1.2843	54.4	40.0	-25.3
1.2870	54.5	40.1	53.7
1.2893	54.4	40.3	25.2
1.2926	54.4	40.3	-12.1
1.2953	53.9	40.3	-143.5
1.2981	53.9	40.3	-5.4
1.3009	54.0	40.4	58.2
1.3035	54.0	40.3	-27.5
1.3064	54.3	40.2	75.5
1.3092	54.4	40.3	46.1
1.3119	54.0	40.2	-157.9
1.3147	53.9	40.1	-19.7
1.3175	54.2	40.2	100.8
1.3202	53.8	40.1	-150.1
1.3230	53.7	40.3	39.3
1.3258	53.7	40.5	38.9
1.3285	53.9	40.7	73.6
1.3313	53.8	40.8	-0.4
1.3341	53.8	41.2	83.9
1.3368	54.1	41.4	144.4
1.3396	53.7	41.5	-85.6
1.3424	53.6	41.5	-39.8
1.3451	53.5	41.5	-31.7

PRE-DIRECT COURSE TEST, 7 OCT 1982 3382 32 1

FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 32 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.23M, W =0.36M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
1.0658	40.1	33.6	
1.0685	40.1	33.6	0.0
1.0713	40.1	33.7	-5.4
1.0741	40.1	33.9	58.7
1.0768	40.1	33.9	1.2
1.0796	40.1	34.1	49.3
1.0824	40.1	34.1	-1.8
1.0851	40.1	34.1	20.2
1.0879	40.3	34.4	105.3
1.0907	40.2	34.6	33.1
1.0934	40.1	34.7	-17.0
1.0962	40.3	34.6	39.3
1.0990	40.3	34.7	1.4
1.1017	40.3	35.0	76.2
1.1045	40.3	34.9	-7.2
1.1073	40.3	35.1	63.5
1.1100	40.3	35.3	38.9
1.1128	40.2	35.4	-2.7
1.1156	40.2	35.6	40.1
1.1183	40.2	35.7	29.2
1.1211	40.2	35.8	13.8
1.1239	40.2	36.0	39.6
1.1266	40.1	36.1	6.2
1.1294	40.2	36.1	26.9
1.1322	40.2	36.2	18.4
1.1349	40.2	36.3	26.9
1.1377	40.3	36.3	19.5
1.1405	40.2	36.4	-5.4
1.1432	40.2	36.4	15.8
1.1460	40.3	36.4	35.7
1.1488	40.3	36.4	-27.6
1.1515	40.2	36.5	6.0
1.1543	40.3	36.5	23.9
1.1571	40.2	36.6	13.5

PRE-DIRECT COURSE TEST, 7 OCT 1982 3382 32 2
FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA
FRAGMENT 32 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG
APPARENT SIZE: L =0.23M, W =0.36M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
1.1598	40.3	36.5	-6.4
1.1626	40.3	36.5	7.7
1.1653	40.3	36.6	15.8
1.1681	40.3	36.5	-7.7
1.1709	40.4	36.6	39.7
1.1736	40.4	36.6	11.4
1.1764	40.4	36.6	-24.2
1.1792	40.2	36.7	-26.4
1.1819	40.2	36.6	1.6
1.1847	40.3	36.7	34.7
1.1875	40.3	36.6	-29.7
1.1902	40.4	36.6	27.6
1.1930	40.4	36.7	19.5
1.1958	40.5	36.7	32.0
1.1985	40.6	36.8	56.9
1.2013	40.4	36.8	-60.1
1.2041	40.3	37.1	51.5
1.2068	40.4	37.3	60.6
1.2096	40.3	37.3	-8.3
1.2124	40.3	37.4	25.7
1.2151	40.3	37.6	17.8
1.2179	40.3	37.7	46.0
1.2207	40.4	37.8	53.4
1.2234	40.4	37.9	34.6
1.2262	40.4	37.9	-11.1
1.2290	40.4	38.2	75.5
1.2317	40.4	38.2	-0.7
1.2345	40.4	38.5	88.1
1.2373	40.4	38.8	52.9
1.2400	40.5	39.0	73.0
1.2428	40.6	39.4	130.9
1.2456	40.4	39.7	57.4
1.2483	40.4	39.9	46.4
1.2511	40.4	40.3	85.5

PRE-DIRECT COURSE TEST, 7 OCT 1982 3382 32 3

FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 32 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.23M, W =0.36M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
1.2539	40.3	40.4	-7.6
1.2566	40.5	40.5	69.7
1.2594	40.5	40.6	15.7
1.2622	40.5	40.6	15.6
1.2649	40.5	40.7	11.8
1.2677	40.6	40.5	-0.5
1.2705	40.6	40.7	54.5
1.2732	40.6	40.8	31.2
1.2760	40.7	41.0	62.2
1.2787	40.7	41.1	11.8
1.2815	40.6	41.3	44.0
1.2843	40.6	41.5	58.7
1.2870	40.5	41.7	20.4
1.2898	40.5	41.9	55.4
1.2926	40.6	41.9	-0.3
1.2953	40.5	42.0	32.4
1.2981	40.5	42.1	4.4
1.3009	40.7	42.3	85.3
1.3036	40.7	42.2	-8.7
1.3064	40.7	42.1	-0.2
1.3092	40.8	42.2	26.9
1.3119	40.7	42.4	36.5
1.3147	40.7	42.4	8.1
1.3175	40.8	42.4	11.1
1.3202	40.7	42.5	-2.5
1.3230	40.8	42.8	86.6
1.3258	40.8	43.0	79.5
1.3285	40.8	43.3	64.4
1.3313	40.6	43.5	18.7
1.3341	40.8	44.0	166.0
1.3368	40.9	44.1	63.0
1.3396	40.7	44.4	24.6
1.3424	40.8	44.6	68.0
1.3451	40.8	44.6	11.4

PRE-DIRECT COURSE TEST, 7 OCT 1982 3382 33 1
FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA
FRAGMENT 33 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG
APPARENT SIZE: L =0.20M, W =0.24M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
1.1128	46.7	21.1	
1.1156	46.7	21.1	0.4
1.1183	46.7	21.2	16.0
1.1211	45.7	21.3	35.9
1.1266	46.7	21.3	-1.3
1.1294	46.7	21.3	-19.8
1.1349	46.7	21.5	23.7
1.1460	46.7	21.3	-10.1
1.1488	46.8	21.4	63.4
1.1515	46.7	21.2	-60.0
1.1543	46.9	21.1	39.6
1.1571	45.7	21.2	-70.9
1.1598	46.4	20.8	-141.8
1.1626	46.4	21.0	37.6
1.1653	46.4	20.9	-13.6
1.1681	46.5	20.9	14.5
1.1709	46.5	20.8	-13.1
1.1736	46.5	20.7	5.4
1.1764	46.6	20.7	14.9
1.1792	46.3	20.7	-104.1
1.1819	46.3	20.5	-21.1
1.1847	46.4	20.5	29.9
1.1875	46.4	20.3	-15.1
1.1902	46.4	20.3	3.3
1.1930	46.5	20.3	6.4
1.1958	46.6	20.2	32.8
1.1985	46.7	20.2	23.4
1.2013	46.5	20.2	-72.3
1.2041	46.3	20.4	-13.9
1.2068	46.3	20.5	18.4
1.2096	46.1	20.2	-120.0
1.2124	46.0	20.2	-24.4
1.2151	46.0	20.5	19.3
1.2179	45.9	20.3	-51.4

PRE-DIRECT COURSE TEST, 7 OCT 1982 3382 33 2

FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 33 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.20M, W =0.24M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
1.2207	46.0	20.4	33.9
1.2234	46.0	20.6	44.2
1.2262	46.0	20.3	-51.4
1.2290	46.0	20.4	22.2
1.2317	45.9	20.5	-19.2
1.2345	46.1	20.9	111.0
1.2373	46.1	21.2	60.5
1.2400	46.2	21.3	40.7
1.2428	46.2	21.7	66.2
1.2456	46.1	22.0	20.1
1.2483	46.1	22.1	-0.6
1.2511	46.0	22.4	31.0
1.2539	45.9	22.4	-26.9
1.2566	46.0	22.6	65.8
1.2649	46.1	22.1	-26.5
1.2705	46.2	22.3	44.9
1.2732	46.1	22.4	-10.0
1.2760	46.1	22.3	-7.2
1.2787	46.1	22.4	-0.2
1.2815	46.0	22.5	-5.2
1.2843	46.0	22.6	7.3
1.2870	45.9	22.7	-24.5
1.2898	46.0	22.9	44.1
1.2926	46.0	22.8	12.2
1.2953	45.9	22.9	-21.9
1.2981	45.9	22.9	-12.2
1.3009	46.0	23.0	51.3
1.3036	46.0	23.0	9.8

PRE-DIRECT COURSE TEST, 7 OCT 1982 3382 34 1

FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 34 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.41M, W =0.14M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
1.1681	42.1	64.2	
1.1709	42.2	64.2	25.3
1.1736	42.2	64.2	-18.2
1.1764	42.1	64.1	-33.5
1.1792	41.8	64.2	-48.8
1.1819	42.0	63.9	-30.9
1.1847	42.0	64.0	28.0
1.1875	41.9	63.8	-88.7
1.1902	41.9	64.0	53.6
1.1930	42.0	64.1	56.6
1.1958	41.9	64.0	-66.9
1.1985	41.8	63.8	-56.9
1.2013	41.7	63.9	-8.3
1.2041	41.7	64.0	44.7
1.2068	41.6	64.1	19.3
1.2096	41.6	64.0	-26.7
1.2124	41.4	64.2	6.7
1.2151	41.3	64.2	-7.1
1.2179	41.2	64.3	9.8
1.2207	41.3	64.4	33.8
1.2234	41.3	64.4	15.7
1.2262	41.3	64.4	-15.7
1.2290	41.3	64.5	44.9
1.2317	41.3	64.6	8.1
1.2345	41.3	64.9	114.4
1.2373	41.1	64.8	-67.3
1.2400	41.1	64.8	12.9
1.2428	41.2	65.3	166.0
1.2456	40.9	65.7	52.2
1.2483	41.0	66.0	113.1
1.2511	40.9	66.1	29.8
1.2539	40.8	66.1	-40.9
1.2566	40.8	66.3	82.1
1.2594	40.7	66.3	-28.4

PRE-DIRECT COURSE TEST, 7 OCT 1982 3382 34 2

FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 34 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.41M, W =0.14M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
1.2677	40.8	66.2	-11.3
1.2705	40.6	66.1	-47.4
1.2732	40.6	66.2	24.5
1.2760	40.7	66.1	-15.9
1.2787	40.6	66.3	48.9
1.2815	40.4	66.4	-12.3
1.2843	40.6	66.6	94.5
1.2870	40.5	66.6	10.4
1.2898	40.5	66.9	78.5
1.2926	40.4	66.9	-27.3
1.2953	40.2	66.9	-26.0
1.2981	40.3	67.0	46.2
1.3036	40.5	67.2	53.3
1.3064	40.5	66.9	-124.1
1.3092	40.4	66.9	-4.6
1.3119	40.3	66.9	-19.7
1.3147	40.3	66.9	9.5
1.3175	40.3	66.8	-45.5
1.3202	40.1	66.7	-50.9
1.3230	40.1	67.1	115.9
1.3258	40.0	67.2	29.9
1.3341	40.4	67.8	81.3

PRE-DIRECT COURSE TEST, 7 OCT 1982 3392 35 1

FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 35 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.81M, W =0.31M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
1.2539	71.4	41.2	
1.2566	71.4	41.2	1.1
1.2594	71.5	41.2	11.4
1.2622	71.4	41.0	-28.9
1.2649	71.4	41.0	-20.6
1.2677	71.5	40.9	21.3
1.2705	71.6	40.9	17.0
1.2732	71.6	40.9	-10.3
1.2760	71.7	40.9	31.2
1.2787	71.5	41.0	-26.1
1.2315	71.5	41.1	22.2
1.2843	71.4	41.3	13.3
1.2870	71.5	41.4	34.8
1.2898	71.5	41.5	1.7
1.2926	71.5	41.7	51.4
1.2953	71.4	41.6	-45.1
1.2981	71.4	41.5	-39.4
1.3009	71.5	41.6	64.9
1.3036	71.5	41.5	-30.9
1.3064	71.5	41.3	-25.1
1.3092	71.5	41.3	-8.4
1.3119	71.4	41.3	-11.4
1.3147	71.4	41.2	-32.9
1.3175	71.4	41.2	3.9
1.3202	71.4	41.3	7.3
1.3230	71.5	41.5	61.0
1.3258	71.4	41.6	8.2
1.3285	71.4	41.7	30.9
1.3313	71.3	41.8	-40.5
1.3341	71.3	42.1	77.2
1.3368	71.5	42.3	79.2
1.3396	71.1	42.4	-87.1
1.3424	71.2	42.5	59.3
1.3451	71.4	42.5	47.9

PRE-DIRECT COURSE TEST, 7 OCT 1982 3382 36 1

FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA

FRAGMENT 36 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG

APPARENT SIZE: L =0.85M, W =0.31M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
1.2677	68.9	39.0	
1.2705	68.9	38.9	1.9
1.2732	68.7	38.3	-174.3
1.2760	68.8	38.2	26.1
1.2815	68.7	39.5	93.6
1.2843	68.6	39.7	-9.2
1.2870	68.4	40.3	63.1
1.2898	68.4	40.6	52.8
1.2926	68.4	40.7	4.9
1.3036	68.3	40.0	-33.7
1.3064	68.4	40.0	9.4
1.3092	68.4	39.9	-17.7
1.3119	68.3	39.9	-14.2
1.3147	68.2	39.9	-25.5
1.3258	68.3	40.4	26.6
1.3285	68.3	40.5	11.4
1.3313	68.2	40.6	-11.1
1.3368	68.1	41.3	58.0
1.3396	68.0	41.5	12.5
1.3424	68.0	41.5	-14.0
1.3451	68.0	41.5	6.4

PRE-DIRECT COURSE TEST, 7 OCT 1982 3332 39 1
FRAGMENT TRAJECTORY FROM CAMERA F-3382 DATA
FRAGMENT 39 CAMERA F-3382 AZIMUTH OF U-AXIS 131.9 DEG
APPARENT SIZE: L =0.83M, W =0.36M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
1.3036	66.7	48.4	
1.3064	67.0	49.8	381.7
1.3092	67.2	49.8	31.8
1.3175	67.0	49.3	-49.9
1.3341	66.9	50.8	51.8
1.3368	67.0	51.1	96.7
1.3396	67.0	51.4	47.7
1.3424	66.8	51.4	-41.8
1.3451	66.9	51.4	3.8

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 1 1

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 1 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.54M, W =0.24M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.0590	6.9	55.9	
0.0618	7.2	57.4	548.1
0.0646	7.7	58.3	325.5
0.0674	8.0	61.2	1049.1
0.0702	8.2	62.7	536.1
0.0730	8.2	64.8	762.3
0.0758	8.8	66.4	574.7
0.0786	9.2	68.0	603.5
0.0813	9.7	69.1	408.7
0.0841	10.1	70.4	479.8
0.0869	10.2	71.8	507.2
0.0897	10.4	72.9	418.8
0.0953	10.9	77.6	846.5
0.0981	11.2	79.2	556.9
0.1009	11.6	80.8	590.9
0.1036	12.0	82.1	488.2
0.1064	12.2	83.8	610.1
0.1092	12.4	85.5	626.5

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 2 1

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 2 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.61M, W =0.23M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.0618	-2.1	60.2	
0.0646	-2.2	62.1	681.1
0.0674	-2.5	63.9	631.3
0.0702	-2.5	65.7	663.9
0.0730	-2.8	67.7	696.2
0.0758	-2.8	69.2	560.2
0.0786	-2.7	71.1	673.9
0.0813	-2.3	72.9	640.6
0.0841	-3.3	74.6	632.2
0.0869	-3.3	76.2	560.8
0.0897	-3.3	78.0	658.0
0.0925	-3.2	79.6	554.9
0.0953	-3.6	81.2	596.3
0.0981	-3.7	82.9	585.6
0.1009	-3.8	84.8	638.4
0.1036	-3.8	86.5	596.1

PRE-DIRECT COURSE TEST, 7 OCT 1982

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 3 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.65M, W =0.16M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.0730	11.2	64.5	
0.0758	11.3	66.1	622.1
0.0786	12.3	67.9	641.3
0.0813	12.9	69.3	557.4
0.0841	12.9	71.0	580.5
0.0869	12.8	72.3	449.3
0.0897	12.9	73.9	568.6
0.0925	13.1	74.8	357.4
0.0953	13.4	76.2	498.5
0.0981	13.5	77.3	394.2
0.1009	13.9	78.8	561.9
0.1036	14.2	80.0	436.9
0.1092	14.7	81.4	255.5
0.1120	14.7	82.3	343.1
0.1148	15.1	83.1	299.5
0.1176	15.3	84.6	538.2

PRE-DIRECT COURSE TEST, 7 OCT 1982 — 3386 4 1

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 4 — CAMERA F-3386 — AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.65M, W =0.21M — TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.0758	6.0	57.3	
0.0786	6.4	58.9	606.1
0.0813	6.6	60.1	432.3
0.0841	6.6	61.5	492.8
0.0869	6.3	63.0	536.5
0.0897	6.4	65.1	725.5
0.0925	6.5	66.2	400.9
0.0953	6.4	67.5	482.2
0.0981	6.5	69.0	521.2
0.1009	6.5	69.3	106.7
0.1036	6.5	70.1	308.1
0.1064	7.2	71.9	657.4
0.1092	7.1	72.1	64.0
0.1148	7.4	72.0	-10.1
0.1176	7.3	74.5	385.2
0.1204	7.2	74.7	54.9
0.1259	7.2	75.6	336.3
0.1287	7.2	76.6	18.1
0.1315	7.2	77.6	363.4
0.1343	7.1	79.1	533.3
0.1371	6.9	80.6	509.9
0.1399	6.9	80.0	-213.1
0.1427	6.8	81.3	459.3
0.1454	6.8	82.3	371.7
0.1482	6.5	82.0	-133.1
0.1510	6.4	82.9	352.6
0.1538	6.6	84.0	392.1

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 5 1

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 5 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.25M, W =0.14M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.0758	56.3	1.5	
0.0786	56.6	1.6	97.6
0.0813	56.7	1.8	59.0
0.0841	55.5	2.0	-60.4
0.0869	55.7	2.2	65.5
0.0897	56.9	2.3	58.7
0.0925	57.0	2.2	55.1
0.0981	57.7	2.5	113.2
0.1009	57.7	2.9	29.1
0.1064	58.6	3.2	153.6
0.1092	59.5	4.0	342.9
0.1120	60.0	4.7	194.4
0.1148	60.8	4.8	301.5
0.1176	61.2	5.3	134.2
0.1232	61.9	6.0	142.6
0.1259	62.8	6.9	373.1
0.1287	63.5	7.9	255.1
0.1315	64.3	8.3	309.3
0.1343	65.1	9.2	325.9
0.1371	65.8	10.0	300.7

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 6 1

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 6 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.22M, W =0.11M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.0925	42.8	24.7	
0.0953	43.4	24.7	197.1
0.0981	43.8	24.9	135.3
0.1009	44.4	25.0	201.8
0.1036	45.3	25.0	290.0
0.1064	45.4	24.8	2.0
0.1092	46.4	25.3	405.8
0.1148	46.9	25.6	95.3
0.1204	47.6	27.0	232.7
0.1232	49.5	28.5	872.3
0.1259	50.1	29.1	301.8
0.1287	51.1	30.4	548.4
0.1315	51.9	30.8	326.8
0.1343	52.3	31.9	293.3
0.1371	53.1	32.9	466.3
0.1399	53.7	33.0	181.3
0.1427	54.4	34.2	429.8
0.1454	55.2	35.3	457.4
~~0.1482~~	~~44.0~~	~~33.7~~	~~4241.9~~
0.1510	56.3	36.5	~~4815.9~~
0.1538	57.5	37.4	520.4
0.1566	58.6	37.8	446.2
0.1594	60.5	39.9	942.3
0.1622	60.6	40.3	121.5
0.1650	61.2	41.2	365.3
0.1677	61.9	42.2	409.2
0.1705	62.7	42.8	344.7
0.1733	63.1	43.6	272.6
0.1761	63.4	44.6	324.5
0.1789	64.1	45.9	452.3
0.1817	64.3	46.0	80.1
0.1845	65.2	47.6	515.9
0.1873	65.8	49.0	479.7
0.1900	66.5	49.5	302.1

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 6 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.22M, W =0.11M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1928	57.0	50.2	294.3

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 7 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.59M, W =0.14M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1009	23.9	76.1	
0.1036	24.7	77.4	555.0
0.1064	25.0	78.9	518.4
0.1092	25.5	80.3	562.2
0.1120	26.5	82.3	770.9
0.1148	27.2	83.4	474.7
0.1176	27.7	85.2	657.5
~~0.1566~~	~~17.9~~	~~76.6~~	~~279.2~~

PRE-DIRECT COURSE TEST, 7 OCT 1982
FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA
FRAGMENT 8 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG
APPARENT SIZE: L =0.56M, W =0.14M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1204	13.8	63.3	
0.1232	14.1	64.3	358.5
0.1259	14.3	65.5	429.1
0.1287	14.7	66.7	464.3
0.1315	15.3	67.8	430.2
0.1343	15.3	68.7	328.0
0.1371	15.6	70.0	458.6
0.1399	15.9	70.4	177.7
0.1427	16.3	72.0	579.7
0.1454	16.6	73.2	455.8
0.1482	16.5	73.7	153.3
0.1510	16.5	74.7	348.4
0.1538	17.3	75.9	478.5
0.1594	17.8	77.6	331.1
0.1622	17.9	78.7	366.7
0.1650	18.2	80.2	550.0
0.1677	18.4	81.4	436.5
0.1705	18.5	81.0	-109.3
0.1733	19.0	81.5	200.5
0.1761	18.6	82.9	455.9
0.1789	18.7	84.4	535.2

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 9 1

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 9 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.54M, W =0.17M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1204	-8.1	72.1	
0.1232	-8.5	73.5	503.4
0.1259	-3.6	74.8	460.5
0.1287	-8.8	76.1	460.5
0.1315	-8.8	77.4	476.8
0.1343	-9.1	78.5	392.3
0.1371	-9.5	80.0	546.0
0.1399	-9.5	80.6	223.5
0.1427	-9.6	82.5	700.4
0.1454	-9.8	83.3	464.0
0.1482	-10.2	84.5	250.4
0.1510	-10.7	85.7	450.2

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 10 1

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 10 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.28M, W =0.09M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1204	-6.4	63.7	
0.1232	-6.5	65.0	452.4
0.1259	-6.7	65.9	342.9
0.1287	-6.9	67.1	410.1
0.1315	-6.8	68.3	437.1
0.1343	-7.1	69.3	367.0
0.1371	-7.0	70.7	509.6
0.1454	-7.0	72.8	249.0
0.1482	-7.2	73.5	234.3
0.1510	-7.1	74.5	357.4
0.1538	-7.2	75.7	428.8
0.1677	-7.3	79.7	295.1
0.1705	-7.8	80.8	370.9

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 11 1

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 11 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.59M, W =0.18M ROTATING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1315	-30.3	64.7	
0.1343	-31.0	65.4	351.9
0.1399	-30.9	66.1	110.4
0.1427	-31.4	68.4	804.1
0.1566	-35.4	72.6	399.5
0.1594	-36.4	73.7	500.2
0.1622	-37.4	75.0	578.0
0.1650	-38.0	76.4	557.8
0.1677	-38.4	77.6	426.9
0.1705	-38.6	78.3	270.1
0.1733	-39.5	78.6	213.3
0.1761	-40.7	79.2	408.4
0.1789	-41.4	80.3	458.5

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 12 1

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 12 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.58M, W =0.27M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1315	26.9	75.3	
0.1343	27.4	76.2	375.6
0.1371	27.9	77.0	296.1
0.1399	28.4	77.8	350.6
0.1427	29.4	78.8	450.3
0.1454	30.1	79.6	369.2
0.1482	30.3	80.1	181.5
0.1510	30.6	80.9	304.1
0.1538	31.6	81.6	374.9
0.1566	32.5	82.4	367.1
0.1594	33.2	83.5	460.7
0.1622	32.9	84.1	185.5
~~0.1650~~	~~27.4~~	~~85.4~~	~~-252.3~~

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 13 1

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 13 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.53M, W =0.21M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1315	44.3	59.5	
0.1343	45.0	60.2	374.9
0.1371	45.8	61.3	467.7
0.1399	46.5	61.7	258.7
0.1427	47.2	63.3	615.5
0.1454	47.0	63.5	12.3
0.1482	47.6	64.1	313.4
0.1510	48.4	64.8	362.4
0.1538	49.1	65.5	334.4
0.1566	49.8	66.0	310.3
0.1594	50.5	67.2	497.9
0.1622	50.5	68.5	366.4
0.1650	51.0	69.4	372.8
0.1677	51.9	70.6	544.3
0.1705	52.6	71.2	322.3
0.1733	52.7	71.1	-30.4
0.1761	52.8	71.2	71.9
0.1789	53.0	72.2	339.0
0.1817	53.6	72.9	309.7
0.1845	54.1	73.8	367.3
0.1873	54.8	74.3	435.0
0.1900	55.0	75.6	286.5
0.1928	55.6	76.6	420.0
0.1956	56.1	77.1	248.0
0.1984	56.6	77.9	358.3
0.2012	57.3	79.0	434.1
0.2040	57.7	79.8	342.4
0.2068	58.3	80.4	289.5

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 14 1

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 14 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.17M, W =0.05M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1399	42.3	27.8	
0.1427	42.9	29.0	433.5
0.1454	43.5	30.3	461.2
0.1482	44.0	30.8	226.3
0.1510	44.6	31.5	329.9
0.1538	45.1	32.4	331.6
0.1566	45.9	33.0	352.6
0.1594	46.8	34.1	494.8
0.1622	46.3	35.2	244.1
0.1650	47.3	36.3	390.6
0.1677	48.0	37.4	417.9
0.1733	49.1	38.0	224.5
0.1761	50.0	39.9	695.0
0.1789	50.2	41.0	283.5
0.1817	50.7	41.7	272.1
0.1845	51.0	42.8	369.7
0.1873	51.5	44.2	463.7
0.1900	51.9	44.6	177.8
0.1928	52.6	45.4	381.5
0.1984	53.3	45.7	144.9
0.2012	53.8	46.6	331.0
0.2040	54.4	47.3	310.1
0.2068	54.9	48.0	290.5

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 15 1

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 15 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.66M, W =0.16M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1622	17.7	72.7	
0.1650	18.2	74.0	476.6
0.1677	18.6	75.2	440.7
0.1705	19.3	75.4	131.2
0.1733	19.5	75.4	23.9
0.1761	19.4	76.5	382.7
0.1817	19.8	77.0	97.2
0.1845	19.9	77.9	337.1
0.1873	20.2	79.3	513.5
0.1928	20.6	80.1	152.1
0.1956	20.7	79.8	-65.9
0.1984	21.3	80.6	329.8
0.2012	21.7	81.5	343.9

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA
FRAGMENT 16 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG
APPARENT SIZE: L =0.61M, W =0.21M ROTATING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1622	1.0	74.2	
0.1650	1.1	75.6	509.8
0.1677	1.1	77.6	727.4
0.1705	0.9	78.0	131.2
0.1733	0.7	78.9	332.0
0.1761	0.6	80.2	463.9
0.1789	0.2	81.7	521.5
0.1817	0.1	82.1	131.9
0.1845	-0.2	83.3	447.8
0.1873	-0.6	84.6	465.7
0.1900	-1.3	85.4	284.7

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 17 1

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 17 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.44M, W =0.41M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.1761	31.7	78.0	
0.1789	32.5	78.8	394.6
0.1817	32.8	79.5	248.6
0.1845	33.1	80.2	301.8
0.1873	33.7	81.6	537.8
0.1900	34.0	82.1	212.8
0.1928	34.6	82.8	291.0
0.1956	35.1	83.5	299.7
0.1984	35.4	84.2	279.6
0.2012	35.5	84.9	242.8
0.2040	35.8	85.5	260.4

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 18 1

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 18 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.41M, W =0.16M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
~~0.1761~~	~~-40.3~~	~~-16.1~~	
0.1789	15.8	79.0	~~13330.4~~
0.1817	16.0	79.9	336.8
0.1845	16.1	80.6	257.1
0.1873	16.5	82.0	512.0
0.1900	16.7	82.2	76.2
0.1928	16.9	83.3	438.0
0.1956	17.2	84.1	270.7
0.1984	17.5	84.9	328.1
0.2012	17.3	85.0	14.6

PRE-DIRECT COURSE TEST, 7 OCT 1982
FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA
FRAGMENT 19 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG
APPARENT SIZE: L =0.37M, W =0.14M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.2096	-5.6	74.5	
0.2123	-5.8	75.2	251.5
0.2151	-6.0	75.4	69.4
0.2179	-6.0	76.5	399.3
0.2207	-5.8	77.3	273.0
~~0.2235~~	~~-7.9~~	~~80.6~~	~~1260.9~~
0.2263	-6.2	79.4	~~500.9~~
0.2291	-6.1	80.3	317.3
0.2319	-6.2	80.8	176.1
0.2346	-6.2	82.1	474.5
0.2374	-6.3	82.9	288.2

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 20 1

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 20 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.56M, W =0.24M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.3071	7.9	71.9	
0.3099	8.2	73.3	484.8
0.3127	8.1	74.1	309.3
0.3155	8.1	73.5	-238.4
0.3183	8.1	73.8	129.7
0.3210	8.3	74.8	345.4
0.3238	8.2	75.0	91.9
0.3266	8.2	75.5	166.2
0.3294	8.4	75.7	67.4
0.3322	8.5	75.6	-23.6
0.3350	8.5	76.3	261.1
0.3378	8.7	76.9	183.8
0.3406	8.7	77.3	170.7
0.3433	8.7	77.6	108.1
0.3461	8.8	78.1	132.0
0.3489	9.0	78.5	154.8
0.3517	9.1	78.9	140.4
0.3545	9.2	79.4	175.2
0.3573	9.0	79.7	89.9
0.3601	9.0	80.2	177.7
0.3629	9.2	80.6	166.3
0.3656	9.5	81.5	323.2
0.3684	9.2	81.6	48.1
0.3712	9.2	82.1	161.5
0.3740	9.2	82.2	43.6
0.3768	9.4	82.8	218.2
0.3796	9.6	83.3	184.1
0.3824	9.6	83.5	57.0
0.3851	9.6	84.0	131.0
0.3879	9.7	84.2	79.1
0.3907	9.9	84.3	47.5
0.3935	10.0	85.0	248.1
0.3963	10.1	85.7	253.2
0.3991	9.9	85.8	49.3

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 20 2

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 20 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.56M, W =0.24M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.4019	10.2	86.6	291.3

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 21 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.45M, W =0.20M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.4047	58.8	26.1	
0.4074	58.9	26.6	99.5
0.4102	58.8	27.1	38.1
0.4130	59.1	27.4	138.3
0.4158	59.3	27.2	46.0
0.4186	59.2	27.3	-6.4
0.4214	59.4	27.7	126.4
0.4242	59.4	28.1	55.8
0.4270	59.4	28.0	-20.0
0.4297	59.6	28.3	85.6
0.4325	59.7	28.2	54.3
0.4353	59.8	28.6	91.9
0.4381	59.7	28.8	-13.3
0.4409	59.6	29.1	-6.1
0.4437	59.9	29.2	139.9
0.4465	60.1	29.5	91.2
0.4493	60.1	29.1	-44.7
0.4520	59.9	29.8	57.1
0.4548	60.5	29.8	191.0
0.4576	60.5	29.9	12.6
0.4604	60.4	30.2	5.0
0.4632	60.5	30.8	123.1
0.4660	60.3	30.5	-112.3
0.4688	60.6	31.3	231.2
0.4716	60.6	31.1	-31.7
0.4743	60.6	31.3	34.1
0.4771	60.7	31.4	56.3
0.4799	61.0	31.7	138.2
0.4827	61.1	31.3	45.8
0.4855	61.0	32.0	1.5
0.4883	61.0	32.2	12.8
0.4911	61.2	32.2	65.4
0.4939	61.4	32.4	110.1
0.4966	61.5	32.8	107.1

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 21 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.45M, W =0.20M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.4994	61.5	32.8	13.1
0.5022	61.5	33.2	44.0
0.5050	61.5	33.4	40.8
0.5078	61.6	33.8	88.4
0.5106	61.8	34.1	114.9
0.5134	61.9	34.0	25.5
0.5161	61.8	33.9	-46.4
0.5189	61.8	34.3	61.2
0.5217	62.1	34.2	65.8
0.5245	62.2	34.4	90.6
0.5273	62.4	34.5	69.7
0.5301	62.2	35.1	33.1
0.5329	62.3	35.4	84.6
0.5357	62.5	35.5	84.0
0.5384	62.5	35.5	-14.8
0.5412	62.5	36.1	126.3
0.5440	62.6	36.0	-1.1
0.5468	63.0	36.1	138.2
0.5496	62.9	36.3	7.5
0.5524	62.8	36.6	27.9
0.5552	63.0	36.6	63.0
0.5580	63.2	36.5	41.9
0.5607	63.4	37.0	175.4
0.5635	63.4	37.1	-17.9
0.5663	63.3	37.4	44.1
0.5691	63.3	37.5	15.5
0.5719	63.2	37.7	-5.0
0.5747	63.3	37.9	88.9
0.5775	63.5	38.2	103.7
0.5803	63.7	38.1	43.8
0.5830	63.5	38.5	27.0
0.5858	63.7	38.7	109.6
0.5886	63.9	38.6	39.5
0.5914	64.0	38.6	15.5

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 21 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.45M, W =0.20M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.5942	63.8	38.8	-21.8
0.5970	63.8	39.2	63.0
0.5998	64.0	39.4	101.9
0.6026	64.2	39.5	103.3
0.6053	64.2	40.0	55.2
0.6081	64.1	40.1	11.5
0.6109	64.3	40.1	53.1
0.6137	64.6	40.3	143.7
0.6165	64.6	40.3	-15.0
0.6193	64.3	40.6	-7.9
0.6221	64.5	40.5	23.2
0.6249	64.8	40.7	124.9
0.6276	65.0	40.9	110.5
0.6304	64.9	41.2	16.5
0.6332	64.9	41.6	71.7
0.6360	64.9	41.6	1.7
0.6388	64.9	42.0	66.5
0.6416	65.0	42.2	108.5
0.6444	65.3	42.4	101.2
0.6471	65.3	42.2	-28.0
0.6499	65.3	42.3	21.8
0.6527	65.3	42.7	71.8
0.6555	65.1	43.1	18.5
0.6583	65.8	42.7	135.5
0.6611	65.7	43.0	30.9
0.6639	65.3	43.2	-73.2
0.6667	65.8	43.5	177.0
0.6694	65.7	43.5	-6.3
0.6722	65.7	43.6	20.5
0.6750	65.7	44.0	87.2
0.6778	66.0	44.2	118.5
0.6806	66.3	44.3	101.0
0.6834	66.3	44.2	-6.4
0.6862	66.5	44.2	41.0

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 21 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.45M, W =0.20M

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.6890	66.5	44.8	122.6
0.6917	66.4	44.4	-81.3
0.6945	66.5	44.8	90.6
0.6973	66.5	44.9	30.5
0.7001	66.6	45.3	94.4
0.7029	66.8	46.0	209.1
0.7057	67.3	46.8	310.1

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 22 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.63M, W =0.15M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.4186	-40.8	43.0	
0.4214	-40.9	43.1	73.1
0.4242	-41.0	43.4	82.1
0.4270	-41.2	43.7	138.6
0.4297	-41.2	43.9	50.1
0.4325	-41.3	43.7	-14.5
0.4353	-41.4	42.4	-314.9
0.4381	-41.7	42.6	105.2
0.4409	-41.9	43.1	166.8
0.4437	-41.5	43.9	124.6
0.4465	-41.6	43.2	-163.2
0.4493	-41.9	43.4	137.4
0.4520	-42.1	43.7	125.3
0.4548	-41.9	43.7	-47.5
0.4576	-41.9	43.9	29.9
0.4604	-42.1	44.2	142.0
0.4632	-42.1	44.3	36.9
0.4660	-42.4	44.6	126.1
0.4688	-42.2	44.9	47.6
0.4716	-42.5	45.1	121.0
0.4743	-43.2	44.8	99.4
0.4771	-42.5	45.5	9.0
0.4799	-42.3	45.5	-58.3
0.4827	-42.6	45.7	137.1
0.4855	-42.8	45.8	75.6
0.4883	-42.8	46.2	108.2
0.4911	-42.8	46.1	-45.3
0.4939	-42.9	46.6	174.2
0.4966	-42.8	46.7	-1.5
0.4994	-43.0	46.8	84.1
0.5022	-42.9	46.9	10.2
0.5050	-43.1	47.0	59.5
0.5078	-43.2	47.3	115.9
0.5106	-43.0	47.5	-7.7

PRE-DIRECT COURSE TEST, 7 OCT 1982
FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA
FRAGMENT 22 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG
APPARENT SIZE: L =0.63M, W =0.15M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.5134	-43.2	47.6	80.1
0.5161	-43.4	47.8	89.4
0.5189	-43.5	49.2	414.1
0.5217	-43.4	49.7	102.7
0.5245	-43.7	49.9	107.8
0.5273	-43.3	49.1	-298.5
0.5301	-43.7	50.0	320.7
0.5329	-43.5	50.1	-4.2
0.5357	-44.0	51.0	377.6
0.5384	-44.4	51.8	310.3
0.5412	-44.8	52.3	228.3
0.5440	-45.4	53.5	456.3
0.5468	-45.4	53.9	105.1
0.5496	-46.1	54.0	183.4
0.5524	-46.2	54.6	197.2
0.5552	-46.6	55.5	328.7
0.5580	-46.9	55.8	174.1
0.5607	-47.6	55.6	379.1

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 23 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.53M, W =0.16M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.4242	-44.1	15.6	
0.4270	-44.2	15.9	76.4
0.4297	-44.1	16.0	-24.8
0.4325	-44.3	16.1	62.0
0.4353	-44.3	16.0	10.2
0.4381	-44.6	16.2	124.8
0.4409	-44.7	16.2	38.0
0.4437	-44.7	16.4	25.7
0.4465	-44.7	16.3	-28.0
0.4493	-44.9	16.4	68.2
0.4520	-45.2	15.3	97.3
0.4548	-45.1	16.3	-40.9
0.4576	-45.0	16.3	-22.9
0.4604	-45.0	16.4	29.3
0.4632	-45.4	16.4	143.2
0.4660	-45.5	16.8	64.9
0.4688	-45.5	17.3	70.0
0.4716	-45.6	17.3	28.7
0.4743	-45.9	16.9	38.3
0.4771	-45.8	17.0	-25.4
0.4799	-45.5	16.7	-125.4
0.4827	-45.9	17.0	163.5
0.4855	-46.0	17.1	52.1
0.4883	-46.3	16.8	86.5
0.4911	-46.3	16.8	-34.7
0.4939	-46.2	16.9	-7.0
0.4966	-46.2	17.3	52.8
0.4994	-46.4	17.2	41.3
0.5022	-46.1	17.3	-65.2
0.5050	-46.8	17.4	226.2
0.5078	-46.9	17.2	23.4
0.5106	-46.8	17.3	-11.4
0.5134	-46.7	17.5	-11.2
0.5161	-47.1	17.5	109.4

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 23 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.53M, W =0.16M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.5189	-47.2	17.7	71.0
0.5217	-47.1	17.4	-77.0
0.5245	-47.1	17.5	22.7
0.5273	-47.1	17.7	29.6
0.5301	-47.5	17.7	128.1
0.5329	-47.5	17.8	6.8
0.5357	-47.5	17.9	4.8
0.5384	-47.7	17.9	74.7
0.5412	-47.9	18.1	103.1
0.5440	-48.1	18.2	78.3
0.5468	-47.9	17.9	-114.6
0.5496	-48.0	18.0	50.8
0.5524	-48.2	18.1	85.6
0.5552	-48.5	18.1	108.0

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 24 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.56M, W =0.21M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.4688	50.4	31.5	
0.4716	50.4	31.5	-33.2
0.4743	50.5	31.6	70.6
0.4771	50.6	31.9	76.1
0.4799	50.8	31.9	79.5
0.4827	51.0	31.9	46.4
0.4855	50.8	32.0	-36.0
0.4883	51.0	32.2	95.9
0.4911	51.0	31.9	-55.1
0.4939	51.1	32.1	73.1
0.4966	51.4	32.5	151.6
0.4994	51.4	32.5	5.6
0.5022	51.3	33.2	93.7
0.5050	51.3	33.1	-18.8
0.5078	51.3	33.1	23.9
0.5106	51.7	33.8	238.5
0.5134	51.9	34.6	217.0
0.5161	52.1	34.8	115.2
0.5189	52.1	35.8	199.8
0.5217	52.4	36.7	254.8
0.5245	52.3	36.7	-16.7
0.5273	52.2	35.3	-139.4
0.5301	52.4	36.8	186.1
0.5329	52.8	37.1	187.3
0.5357	52.9	37.8	143.1
0.5384	53.0	38.6	216.3
0.5412	53.1	39.0	124.2
0.5440	52.8	40.1	145.4
0.5468	53.1	41.1	321.7
0.5496	53.4	41.5	158.8
0.5524	53.8	42.2	236.1
0.5552	54.3	43.5	469.8
0.5580	54.8	43.7	165.3
0.5607	55.0	44.2	187.0

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 24 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.56M, W =0.21M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.5635	55.3	45.1	252.3
0.5663	55.3	45.3	75.4
0.5691	55.5	45.7	141.8
0.5719	55.9	46.6	297.5
0.5747	56.1	47.1	206.8
0.5775	56.2	47.6	117.5
0.5803	56.5	48.2	221.6
0.5830	56.9	48.4	152.0
0.5858	57.2	49.4	315.8
0.5886	57.6	50.3	345.7

PRE-DIRECT COURSE TEST, 7 OCT 1982
FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA
FRAGMENT 25 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG
APPARENT SIZE: L =0.53M, W =0.14M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.5384	44.1	9.8	
0.5412	44.3	9.9	59.2
0.5440	44.4	9.8	29.6
0.5468	44.9	9.7	160.5
0.5496	44.9	9.7	0.0
0.5524	44.9	10.0	14.0
0.5552	45.1	9.8	78.4
0.5580	45.4	9.6	90.1
0.5607	45.7	9.9	108.4
0.5635	45.9	10.3	105.3
0.5663	46.0	10.4	57.9
0.5691	46.1	10.2	1.1
0.5719	46.3	10.4	102.9
0.5747	46.5	10.5	85.8
0.5775	46.7	10.6	63.5
0.5803	46.9	10.6	65.5
0.5830	47.0	10.5	28.3
0.5858	47.3	11.0	141.9
0.5886	47.6	10.6	74.4
0.5914	48.0	10.6	158.4
0.5942	48.0	10.6	-8.0
0.5970	48.1	10.8	35.2
0.5998	48.1	11.0	13.9
0.6026	48.5	11.0	148.3
0.6053	48.4	11.2	1.2
0.6081	48.5	11.3	39.6
0.6109	49.0	11.6	201.4
0.6137	49.5	11.4	150.8
0.6165	49.5	11.4	-11.1
0.6193	49.4	11.4	-34.9
0.6221	49.7	11.3	114.2
0.6249	50.1	11.0	99.5
0.6276	50.3	11.1	75.2
0.6304	50.4	11.7	94.7

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 25 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.58M, H =0.14M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.6332	50.5	11.7	39.4
0.6360	50.5	11.8	18.3
0.6388	50.7	11.9	71.6
0.6416	51.2	12.2	183.7
0.6444	51.4	12.1	31.9
0.6471	51.6	12.0	38.1
0.6499	51.8	11.9	80.9
0.6527	51.7	12.2	-14.1
0.6555	52.0	12.0	108.7
0.6583	52.3	12.1	103.5
0.6611	52.5	12.2	61.4
0.6639	52.5	12.4	13.0
0.6667	52.9	12.5	145.8
0.6694	53.1	12.5	90.1
0.6722	53.0	12.4	-68.7
0.6750	53.2	12.5	83.7
0.6778	53.4	12.8	113.6
0.6806	53.9	12.7	151.0
0.6834	54.0	12.6	19.8
0.6862	54.1	13.1	92.3
0.6890	54.3	12.9	53.2
0.6917	54.6	12.6	75.8
0.6945	54.6	12.7	25.7
0.6973	54.9	13.0	109.4
0.7001	55.2	13.1	125.3
0.7029	55.1	13.1	-37.1
0.7057	55.3	13.3	61.4
0.7085	55.5	13.4	87.9
0.7113	55.7	13.3	84.8
0.7140	56.0	13.4	97.5
0.7168	56.1	13.3	15.7
0.7196	56.6	13.6	221.1
0.7224	56.8	13.4	28.6
0.7252	57.2	13.2	119.8

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 25 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.58M, W =0.14M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.7280	57.0	13.4	-31.3
0.7308	57.0	13.9	16.2
0.7336	57.3	13.8	98.2
0.7391	57.9	14.1	128.1
0.7419	57.7	14.2	-65.0
0.7447	58.1	14.1	125.7
0.7475	58.4	14.2	118.5
0.7503	58.5	13.9	-7.5
0.7531	58.5	14.0	6.4
0.7558	58.6	13.9	44.6
0.7586	59.0	14.2	144.2
0.7614	59.3	13.9	84.2
0.7642	59.3	14.2	48.3
0.7670	59.5	14.6	93.2
0.7698	59.5	14.5	-1.4
0.7726	60.0	14.5	169.8
0.7754	59.9	14.7	-10.0
0.7781	60.2	14.6	83.0
0.7809	60.7	14.5	154.8
0.7837	60.6	14.6	-25.0
0.7865	60.7	14.7	43.9
0.7893	61.1	14.6	133.0
0.7921	61.4	14.6	99.5
0.7949	61.4	14.9	47.5
0.7977	61.5	15.0	48.0
0.8004	61.8	15.0	80.1

PRE-DIRECT COURSE TEST, 7 OCT 1982
FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA
FRAGMENT 26 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG
APPARENT SIZE: L =0.75M, W =0.25M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.5663	53.2	34.9	
0.5691	53.2	34.9	-4.8
0.5719	53.1	34.8	-31.6
0.5747	53.2	35.5	152.7
0.5775	53.5	35.3	44.2
0.5803	53.8	36.1	255.9
0.5830	54.0	36.7	170.0
0.5858	54.2	37.2	181.3
0.5886	54.4	37.7	135.7
0.5914	54.9	37.8	180.3
0.5942	54.9	37.6	-38.4
0.5970	54.8	37.9	15.8
0.5998	55.1	38.9	305.1
0.6026	55.2	38.8	16.7
0.6053	55.4	39.4	176.3
0.6081	55.7	40.3	264.1
0.6109	56.7	41.6	569.4
0.6137	56.8	42.3	169.0
0.6165	56.8	42.0	-56.7

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 27 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.68M, W =0.15M ROTATING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.5775	51.7	4.6	
0.5803	51.9	4.4	61.9
0.5830	52.1	4.6	102.2
0.5858	52.1	5.1	12.0
0.5886	52.7	4.7	195.3
0.5914	52.9	4.6	64.8
0.5942	53.1	4.8	67.4
0.5970	52.9	4.9	-53.4
0.5998	53.5	5.1	210.6
0.6026	54.0	5.1	180.5
0.6053	54.5	5.1	181.6
0.6081	54.1	5.3	-145.6
0.6109	54.4	5.4	117.0
0.6137	54.8	4.8	137.5
0.6165	54.8	4.7	-8.2
0.6193	55.0	5.0	72.5
0.6221	55.2	4.9	74.1
0.6249	55.6	4.5	114.7
0.6276	55.9	4.6	116.1
0.6304	56.2	4.7	121.8
0.6332	56.4	5.0	66.1
0.6360	56.4	5.2	17.1
0.6388	56.6	4.8	60.3
0.6416	56.9	5.1	101.2
0.6444	57.3	5.3	168.3
0.6471	57.6	5.0	98.3
0.6499	57.8	5.0	69.9
0.6527	57.8	5.1	12.8
0.6555	58.3	5.0	149.8
0.6583	58.6	4.9	132.0

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 28 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.16M, W =0.24M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.6137	42.8	38.5	
0.6165	42.8	38.2	-79.4
0.6193	42.6	38.2	-58.4
0.6221	42.5	38.2	-37.6
0.6249	42.9	38.1	82.3
0.6276	43.0	38.2	64.2
0.6304	43.0	38.6	87.3
0.6332	42.8	38.8	18.9
0.6360	42.8	38.9	-17.6
0.6388	42.7	39.1	57.2
0.6416	42.8	39.5	113.8
0.6444	43.0	39.5	51.7
0.6471	43.1	39.5	17.7
0.6499	43.0	39.6	-15.2
0.6527	42.9	39.8	26.5
0.6555	43.2	39.7	64.2
0.6583	43.2	39.6	-26.9
0.6611	43.2	39.8	44.3
0.6639	43.0	40.2	67.9
0.6667	43.2	40.4	64.1
0.6694	43.3	40.5	60.4
0.6722	43.1	40.4	-52.9
0.6750	43.0	40.7	41.4
0.6778	43.2	41.0	108.1
0.6806	43.6	41.1	142.3
0.6834	43.4	41.0	-84.3
0.6862	43.3	41.3	45.3
0.6890	43.3	41.3	16.3
0.6917	43.5	41.3	49.3
0.6945	43.8	42.1	274.2
0.6973	43.9	43.2	286.3
0.7001	43.8	43.7	108.4
0.7029	43.6	44.4	130.1
0.7057	43.5	45.0	123.4

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 28 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.16M, W =0.24M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.7113	43.6	45.1	28.0
0.7196	43.7	45.6	47.8
0.7280	43.3	46.7	65.5
0.7308	43.5	47.4	243.2
0.7391	43.3	47.8	16.9
0.7447	43.6	48.3	92.2
0.7475	43.6	49.5	335.0
0.7503	43.5	49.4	-57.3
0.7531	43.6	50.0	182.3
0.7558	43.4	50.6	130.6
0.7614	43.5	51.4	122.8
0.7642	43.5	52.1	187.2
0.7670	43.3	52.4	52.3
0.7698	43.3	53.3	251.8
0.7726	43.3	54.4	283.1
0.7754	43.2	54.9	132.7
0.7781	43.3	56.1	362.0
0.7809	43.1	57.4	330.5
0.7837	42.8	57.5	-63.4
0.7865	42.9	57.9	159.2

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 29 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.60M, W =0.17M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.6778	-47.4	36.0	
0.6806	-47.4	36.6	132.6
0.6834	-47.4	36.7	23.1
0.6862	-47.4	36.7	9.5
0.6890	-47.3	37.4	123.4
0.6917	-47.3	37.5	-4.6
0.6945	-47.2	38.6	245.6
0.6973	-47.1	38.6	-34.6
0.7001	-47.1	39.0	110.2
0.7029	-47.3	39.9	235.2
0.7057	-47.4	41.3	357.2
0.7085	-47.4	42.2	212.0
0.7113	-47.3	42.9	147.5
0.7196	-47.5	43.8	89.1
0.7224	-47.9	44.3	237.9
0.7252	-48.0	45.3	272.7
0.7280	-48.2	46.7	390.5
0.7308	-48.4	47.2	189.1
0.7336	-48.8	48.0	295.1

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 30 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.47M, W =0.36M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.6778	-46.0	58.1	
0.6806	-45.9	58.3	42.7
0.6834	-46.0	57.8	-116.4
0.6862	-46.0	57.7	-27.8
0.6890	-46.0	58.1	134.8
0.6917	-46.1	58.0	-34.3
0.6945	-46.1	57.8	-46.7
0.6973	-46.0	58.0	40.5
0.7001	-45.9	58.2	29.3
0.7029	-46.4	58.2	117.6
0.7057	-46.2	59.3	246.9
0.7085	-46.4	59.7	178.7
0.7113	-46.4	60.0	95.3
0.7140	-46.4	60.7	181.7
0.7168	-46.4	61.3	164.5
0.7196	-46.3	62.5	334.5
0.7224	-46.4	63.4	274.5
0.7252	-46.4	64.3	268.5
0.7280	-46.5	65.8	462.7
0.7308	-46.2	66.6	174.0
0.7336	-46.3	66.8	68.3
0.7363	-46.5	68.0	398.7
0.7391	-46.4	68.0	-19.4
0.7419	-46.6	68.8	274.7
0.7447	-46.3	69.6	173.0
0.7475	-46.4	70.8	377.1
0.7503	-46.5	71.2	143.7
0.7531	-46.4	71.7	120.9
0.7558	-46.3	72.4	197.1
0.7586	-45.3	72.8	116.3
0.7614	-46.2	74.1	375.5
0.7642	-46.4	75.4	442.7
0.7670	-46.4	76.1	209.8
0.7698	-45.4	77.4	408.6

PRE-DIRECT COURSE TEST, 7 OCT 1982 3385 30 2

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 30 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.47M, W =0.36M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.7726	-46.5	78.3	280.4

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 31 1

FRAGMENT TRAJECTORY FROM CAMERA F-3385 DATA

FRAGMENT 31 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.32M, W =0.24M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.7113	64.1	36.4	
0.7140	64.3	36.5	53.0
0.7168	64.3	36.3	-26.0
0.7196	64.5	36.8	152.5
0.7224	64.8	36.3	32.2
0.7252	64.7	36.6	11.7
0.7280	64.9	36.6	50.2
0.7308	65.4	37.1	257.6
0.7336	65.8	37.1	130.1
0.7363	65.8	37.4	47.9
0.7391	66.5	37.8	280.4
0.7419	66.6	37.5	-24.6
0.7447	66.8	38.4	231.9

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 32 1

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 32 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.36M, W =0.13M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.7893	58.7	40.7	
0.7921	58.9	40.8	53.5
0.7949	59.0	41.0	78.3
0.7977	59.1	41.4	123.7
0.8004	59.1	41.5	21.1
0.8032	58.8	41.4	-112.7
0.8060	58.7	41.5	1.8
0.8088	58.6	41.8	26.4
0.8116	58.1	43.0	119.1
0.8144	57.9	44.1	174.3
0.8172	58.0	43.7	-68.3
0.8200	57.6	44.3	23.9
0.8227	57.6	44.9	138.3
0.8255	57.4	45.9	158.8
0.8283	57.8	46.9	351.6
0.8311	58.0	47.0	49.7
0.8339	58.2	47.4	172.3
0.8367	58.2	47.8	95.3
0.8395	58.5	48.9	314.4

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 33 1

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 33 CAMERA F-3385 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.45M, W =0.14M ROTATING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.8032	57.8	30.6	
0.8060	57.6	30.7	-44.2
0.8088	57.5	29.2	-282.9
0.8116	57.4	32.1	476.4
0.8144	57.6	32.2	61.4
0.8172	57.6	32.0	-31.7
0.8200	57.3	32.1	-79.2
0.8227	57.5	32.2	67.9
0.8255	57.5	32.3	27.9
0.8283	57.6	32.5	63.3
0.8311	57.8	32.6	76.9
0.8339	57.7	33.2	63.7
0.8367	57.7	33.7	117.0
0.8395	57.7	32.9	-139.8
0.8423	57.8	33.1	71.4
0.8478	57.7	32.9	-44.9
0.8506	57.9	34.1	285.2
0.8534	57.9	34.2	20.5
0.8562	58.2	34.7	179.2
0.8590	58.7	35.1	223.5
0.8618	58.8	36.4	280.6

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 34 1
FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA
FRAGMENT 34 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG
APPARENT SIZE: L =0.22M, W =0.15M ROTATING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.8032	44.5	46.6	
0.8060	44.3	46.8	-9.1
0.8088	44.3	47.1	86.4
0.8116	44.3	47.2	33.8
0.8144	44.6	47.3	102.5
0.8172	44.5	48.2	182.7
0.8200	44.3	47.1	-323.1
0.8227	44.3	48.0	238.5
0.8255	44.7	47.5	-20.4
0.8283	44.8	47.9	119.0
0.8311	44.7	47.9	-11.0
0.8339	44.7	48.7	192.2
0.8367	44.5	48.6	-74.8
0.8395	44.9	49.6	354.2
0.8423	45.0	48.9	-170.7
0.8450	45.1	50.2	385.3
0.8478	44.8	48.7	-457.3
0.8506	45.0	48.9	88.9
0.8534	45.0	49.0	37.1
0.8562	45.1	48.9	-22.8
0.8590	45.0	49.0	30.5
0.8618	45.0	49.4	69.3
0.8646	45.0	49.5	38.0
0.8673	45.1	49.5	37.8
0.8701	45.3	49.8	114.2
0.8729	45.1	49.8	-41.2
0.8757	45.0	49.8	-35.1
0.8785	45.2	50.0	96.1
0.8813	45.5	50.2	128.3
0.8841	45.4	50.0	-49.7
0.8868	45.4	50.0	-23.8
0.8896	45.3	50.2	24.5
0.8924	45.2	50.4	40.0
0.8952	45.3	50.5	77.1

PRE-DIRECT COURSE TEST, 7 OCT 1982
FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA
FRAGMENT 34 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG
APPARENT SIZE: L =0.22M, W =0.15M ROTATING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.8980	45.5	50.7	96.5
0.9008	45.5	50.9	22.7
0.9036	45.5	51.1	59.6
0.9064	45.5	51.1	28.4
0.9091	45.5	51.2	4.8
0.9119	45.6	51.3	48.7
0.9147	45.6	51.4	29.9
0.9175	45.6	51.3	-29.4
0.9203	45.7	51.4	76.1
0.9231	45.8	51.5	34.5
0.9259	45.8	51.7	37.1
0.9287	45.7	51.8	20.2
0.9314	45.7	52.0	33.8
0.9342	46.0	52.1	97.6
0.9370	46.0	52.5	136.2
0.9398	45.9	52.3	-86.3
0.9426	45.8	52.6	38.3
0.9454	45.8	52.7	46.2
0.9482	46.3	52.6	90.7
0.9510	46.3	52.6	-4.8
0.9537	46.2	52.7	3.2
0.9565	45.9	52.8	-29.1
0.9593	46.1	53.0	76.6
0.9621	46.1	53.3	101.8
0.9649	46.3	53.3	49.6
0.9677	46.4	53.2	-19.6
0.9705	46.5	53.6	130.1
0.9733	46.4	53.8	32.7
0.9760	46.4	53.7	-25.3
0.9788	46.5	53.7	22.9
0.9816	46.4	53.9	35.2
0.9844	46.5	53.9	32.1
0.9872	46.6	54.2	103.9
0.9900	46.7	54.2	6.2

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 34 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.22M, W =0.15M ROTATING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.9928	46.8	54.2	26.6
0.9956	46.6	54.4	17.5
0.9983	46.6	54.7	81.9
1.0011	46.8	54.7	67.0
1.0039	47.0	55.1	135.5
1.0067	46.8	55.2	-21.8
1.0095	46.6	55.5	51.4
1.0123	46.7	55.4	-10.9
1.0151	47.0	55.5	103.8
1.0178	47.1	55.5	17.0
1.0206	47.1	55.7	45.7
1.0234	47.1	55.7	0.7
1.0262	46.9	56.0	42.9
1.0290	46.9	56.3	68.7
1.0318	47.3	56.5	143.7
1.0346	47.3	56.6	39.4
1.0374	47.1	56.8	-9.8
1.0401	47.1	56.9	53.3
1.0429	47.4	56.8	32.5
1.0457	47.4	56.8	-2.2
1.0485	47.3	56.6	-81.8
1.0513	47.4	56.6	19.0
1.0541	47.4	56.9	95.8
1.0569	47.6	57.2	131.5
1.0597	47.7	57.0	-20.7
1.0624	47.5	57.2	-6.3
1.0652	47.4	57.6	104.5
1.0680	47.5	57.6	6.4
1.0708	47.9	57.8	143.5
1.0736	47.6	57.8	-67.5
1.0764	47.6	57.9	23.7
1.0792	47.7	57.7	-44.5
1.0820	48.0	58.0	140.8
1.0847	48.1	57.7	-50.1

PRE-DIRECT COURSE TEST, 7 OCT 1982

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 34 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.22M, W =0.15M ROTATING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
1.0875	48.2	57.9	83.3
1.0903	48.2	58.0	22.0
1.0931	47.9	58.0	-47.6
1.0959	47.8	58.3	65.0
1.0987	48.3	58.5	141.6
1.1015	48.4	58.5	34.9
1.1043	48.3	58.5	-16.1
1.1070	47.9	58.8	-1.7
1.1098	48.2	58.7	33.0
1.1126	48.6	58.6	61.9
1.1154	48.6	58.8	44.8
1.1182	48.3	58.6	-120.4
1.1210	48.3	58.9	78.3
1.1238	48.5	59.3	171.8
1.1266	48.8	59.3	58.5
1.1293	48.6	59.5	21.5
1.1321	48.7	59.9	115.5
1.1349	48.7	59.8	-16.9
1.1377	48.9	59.8	59.1
1.1405	48.9	59.9	33.3
1.1433	48.8	60.2	42.3
1.1461	48.9	60.2	17.9
1.1488	49.2	60.4	117.8
1.1516	49.2	60.2	-49.6
1.1544	49.0	60.6	74.2
1.1572	49.0	60.7	22.2
1.1600	49.0	60.9	63.2
1.1628	49.2	61.1	90.0
1.1656	49.2	61.3	48.1
1.1684	49.3	61.2	6.2
1.1711	49.3	61.6	119.5
1.1739	49.4	62.0	134.9
1.1767	49.7	61.6	-51.2
1.1795	49.5	61.7	-10.7

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 34 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.22M, W =0.15M ROTATING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
1.1823	49.6	61.9	77.6
1.1851	49.6	61.8	-34.9
1.1879	49.5	61.6	-65.0
1.1907	49.6	62.0	116.9
1.1934	49.8	62.1	77.4
1.1962	49.8	62.4	83.0
1.1990	49.8	62.4	14.3
1.2018	49.8	62.5	2.3
1.2046	50.0	62.6	72.9
1.2074	50.0	62.6	3.5
1.2102	50.1	62.6	27.5
1.2130	50.0	62.5	-42.7
1.2157	50.2	62.8	131.0
1.2185	50.5	62.8	49.8
1.2213	50.3	62.6	-90.9
1.2241	50.3	62.7	35.7
1.2269	50.2	62.9	36.0
1.2297	50.2	63.2	76.1
1.2325	50.6	63.4	149.3
1.2353	50.7	63.3	-9.1
1.2380	50.4	63.5	-7.5
1.2408	50.4	63.5	-3.5
1.2436	50.4	63.4	-25.0
1.2464	50.6	63.4	30.0
1.2492	50.8	63.6	98.3
1.2520	50.8	63.7	33.9
1.2548	50.8	63.7	-2.6
1.2575	50.8	63.7	11.6
1.2603	50.9	64.2	162.0
1.2631	51.0	64.3	51.6
1.2659	51.1	64.3	21.2
1.2687	51.1	64.3	-9.0
1.2715	51.1	64.6	69.2
1.2743	51.1	64.4	-21.8

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 34 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.22M, W =0.15M ROTATING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
1.2771	51.5	64.7	152.1
1.2798	51.5	64.6	-27.3
1.2826	51.4	64.5	-49.3
1.2854	51.3	64.6	15.6
1.2882	51.3	64.8	58.0
1.2910	51.7	64.8	95.7
1.2938	51.6	64.9	-9.7
1.2966	51.5	65.1	36.4
1.2994	51.5	65.2	45.5
1.3021	52.0	65.1	63.1
1.3049	52.0	65.1	-3.5
1.3077	51.6	65.2	-50.9
1.3105	51.5	65.3	-5.7
1.3133	52.1	65.3	147.7
1.3161	52.2	65.1	-40.4
1.3189	52.1	65.4	76.2
1.3217	51.8	65.3	43.3
1.3244	51.9	65.7	-17.4
1.3272	52.2	65.8	36.9
1.3300	52.2	65.7	-15.4
1.3328	52.1	66.1	90.1
1.3356	52.3	66.1	53.8
1.3384	52.3	66.1	-13.5
1.3412	52.6	65.9	3.7
1.3440	52.4	66.3	69.7
1.3467	52.6	66.2	25.3

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 35 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.53M, W =0.23M ROTATING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.8032	-46.5	19.7	
0.8060	-46.9	19.8	151.5
0.8088	-46.7	19.8	-39.8
0.8116	-46.8	20.0	38.3
0.8144	-46.5	20.0	-97.3
0.8172	-46.5	19.9	-26.4
0.8200	-46.7	19.9	96.6
0.8227	-46.6	20.1	-7.2
0.8255	-46.6	20.2	8.5
0.8283	-46.4	20.4	-42.6
0.8311	-46.5	20.4	18.6
0.8339	-46.6	20.6	88.7
0.8367	-46.6	20.9	39.9
0.8395	-46.7	20.8	4.9
0.8423	-46.5	21.1	-8.1
0.8450	-46.2	20.8	-141.0
0.8478	-46.4	21.0	93.4
0.8506	-46.6	21.6	140.9
0.8534	-46.3	20.9	-217.0
0.8562	-46.1	20.9	-36.4
0.8590	-46.2	20.9	33.1
0.8618	-46.3	20.8	-1.0
0.8646	-46.4	21.2	105.2
0.8673	-46.1	21.0	-121.6
0.8701	-46.0	21.3	14.2
0.8729	-46.2	21.4	74.5
0.8757	-46.4	21.4	56.9

PRE-DIRECT COURSE TEST, 7 OCT 1982
FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA
FRAGMENT 36 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG
APPARENT SIZE: L =0.62M, W =0.19M ROTATING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.8032	-46.1	39.1	
0.8060	-46.3	39.1	75.3
0.8088	-46.8	39.6	244.1
0.8116	-46.7	39.6	-15.7
0.8144	-46.3	39.6	-137.4
0.8172	-46.2	39.1	-112.1
0.8200	-46.7	39.4	202.1
0.8227	-46.8	39.8	102.7
0.8255	-46.6	39.7	-51.0
0.8283	-46.9	40.1	134.8
0.8311	-46.7	40.0	-78.3
0.8339	-47.1	40.5	228.1
0.8367	-47.0	40.3	-59.1
0.8395	-46.8	40.5	-12.0
0.8423	-46.9	40.7	68.4
0.8450	-47.0	40.5	-4.6
0.8478	-47.1	40.5	11.6
0.8506	-47.2	40.7	93.3
0.8534	-47.4	40.9	109.4
0.8562	-47.2	40.7	-132.4
0.8590	-47.2	40.7	3.7
0.8618	-47.4	41.0	127.0
0.8646	-47.3	40.7	-94.6
0.8673	-47.2	40.9	36.4
0.8701	-48.0	42.2	516.8

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 37 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.66M, W =0.20M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.8172	62.9	15.3	
0.8200	62.7	15.3	-69.1
0.8227	63.1	15.5	151.6
0.8255	63.4	15.6	131.0
0.8283	63.8	15.8	137.3
0.8311	63.9	15.8	56.6
0.8339	64.1	15.9	74.5
0.8367	64.1	16.0	18.0
0.8395	64.2	16.1	35.9
0.8423	64.5	16.4	123.2
0.8450	64.5	16.4	28.8
0.8478	64.8	16.2	48.0
0.8506	65.1	16.2	99.2
0.8534	65.1	16.2	20.7
0.8562	65.6	16.3	186.2
0.8590	65.8	16.1	33.2
0.8618	65.8	16.4	30.3
0.8646	65.9	16.5	36.0
0.8673	66.0	16.6	62.1
0.8701	66.3	16.9	132.8
0.8729	66.4	16.6	9.2

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 38 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.43M, W =0.08M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.8172	50.4	37.3	
0.8200	50.1	37.5	-54.8
0.8227	50.6	37.9	234.5
0.8255	50.4	37.9	-35.2
0.8283	50.5	38.0	25.1
0.8311	50.5	37.9	-4.7
0.8339	50.4	38.0	0.2
0.8367	50.4	38.2	25.5
0.8395	50.5	38.3	52.4
0.8423	50.6	38.0	-33.6
0.8450	50.4	38.3	20.0
0.8478	50.4	38.4	9.3
0.8506	50.3	38.2	-69.9
0.8534	50.3	38.3	26.5
0.8562	50.2	38.6	18.3
0.8590	50.9	38.7	228.5
0.8618	50.4	38.3	-237.7
0.8646	50.9	39.1	309.7
0.8673	50.5	39.1	-95.5
0.8701	50.5	39.3	53.5
0.8729	50.7	40.1	205.7
0.8757	50.5	39.7	-116.9

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 39 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.36M, W =0.14M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.8450	46.3	38.9	
0.8478	46.3	39.0	17.0
0.8506	46.2	39.0	6.7
0.8534	46.4	39.0	31.1
0.8562	47.0	39.1	191.8
0.8590	46.5	39.0	-177.4
0.8618	46.4	39.2	33.4
0.8646	46.3	39.4	10.9
0.8673	47.1	38.8	89.6
0.8701	46.6	39.9	103.0
0.8729	46.4	39.6	-108.6
0.8757	46.8	40.3	269.8

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 40 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.57M, W =0.21M TUMBLING

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
0.8450	-45.0	26.0	
0.8478	-45.2	25.9	47.9
0.8506	-45.2	25.9	-11.4
0.8534	-45.3	25.8	18.3
0.8562	-45.3	26.0	39.2
0.8590	-45.3	26.0	-15.6
0.8618	-45.5	26.7	193.8
0.8646	-45.4	26.9	7.5
0.8673	-45.6	26.3	-46.4
0.8701	-45.5	26.8	46.5
0.8729	-45.9	27.3	249.7
0.8757	-46.3	27.5	128.4

PRE-DIRECT COURSE TEST, 7 OCT 1982
FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA
FRAGMENT 41 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG
APPARENT SIZE: L =0.56M, W =0.21M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
5.8899	14.9	74.8	
5.8927	15.0	74.2	-190.9
5.8955	15.1	74.0	-69.6
5.8983	15.2	73.8	-74.0
5.9011	15.2	73.8	21.3
5.9038	15.0	73.8	-33.7
5.9066	15.1	73.3	-165.0
5.9094	15.1	73.5	81.8
5.9122	15.3	72.9	-188.1
5.9150	15.3	72.9	1.1
5.9178	15.2	72.7	-88.6
5.9206	15.1	72.4	-96.5
5.9234	15.1	72.2	-71.7
5.9261	15.2	72.0	-70.5
5.9289	15.2	72.1	34.7
5.9317	15.3	71.7	-141.8
5.9345	15.4	71.5	-72.4
5.9373	15.1	71.4	-36.7
5.9401	15.3	71.2	-59.9
5.9429	15.3	71.2	-13.2
5.9457	15.2	70.9	-94.5
5.9484	15.3	70.6	-102.4
5.9512	15.3	70.6	-10.3
5.9540	15.3	70.4	-71.5
5.9568	15.4	70.1	-87.8
5.9596	15.2	70.2	18.4
5.9624	15.4	69.9	-107.8
5.9652	15.4	69.2	-218.5
5.9680	15.4	69.1	-40.3
5.9707	15.3	68.9	-95.9
5.9735	15.4	68.8	-26.9
5.9763	15.5	68.7	-3.1
5.9791	15.5	68.5	-89.3
5.9819	15.5	68.3	-63.8

PRE-DIRECT COURSE TEST, 7 OCT 1982

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 41 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.56M, W =0.21M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
5.9847	15.5	68.0	-87.4
5.9875	15.5	67.6	-131.9
5.9903	15.4	67.5	-65.2
5.9930	15.4	67.3	-66.2
5.9958	15.5	67.2	-36.5
5.9986	15.6	67.0	-61.0
6.0014	15.5	66.8	-60.3
6.0042	15.4	66.6	-93.7
6.0070	15.4	66.5	-44.6
6.0098	15.6	66.2	-69.9
6.0126	15.6	66.0	-69.3
6.0153	15.5	65.9	-56.5
6.0181	15.6	65.7	-43.6
6.0209	15.5	65.4	-142.5
6.0237	15.4	65.4	-5.2
6.0265	15.5	65.0	-130.0
6.0293	15.5	64.7	-76.5
6.0321	15.6	64.9	53.9
6.0348	15.5	64.6	-101.0
6.0376	15.3	64.3	-111.8
6.0404	15.5	64.2	-38.2
6.0432	15.5	64.2	8.5
6.0460	15.5	63.9	-107.1
6.0488	15.4	63.6	-106.6
6.0516	15.5	63.5	-12.9
6.0544	15.5	63.4	-63.7
6.0571	15.5	63.0	-126.3
6.0599	15.4	63.0	8.6
6.0627	15.6	62.7	-122.4
6.0655	15.7	62.4	-88.9
6.0683	15.4	62.2	-100.7
6.0711	15.3	62.2	-5.4
6.0739	15.5	61.6	-170.7
6.0767	15.7	61.7	42.8

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 41 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.56M, W =0.21M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
6.0794	15.6	61.2	-191.0
6.0822	15.4	61.1	-53.9
6.0850	15.4	61.0	-27.7
6.0878	15.5	60.7	-99.7
6.0906	15.5	60.5	-66.4
6.0934	15.4	60.6	37.3
6.0962	15.4	60.2	-149.4
6.0990	15.4	59.9	-105.0
6.1017	15.4	59.7	-67.7
6.1045	15.4	59.7	-1.5
6.1073	15.3	59.3	-156.2
6.1101	15.5	59.1	-38.2
6.1129	15.4	59.0	-34.9
6.1157	15.4	58.8	-88.2
6.1185	15.4	58.6	-59.5
6.1213	15.6	58.3	-100.0
6.1240	15.3	58.2	-43.9
6.1268	15.4	58.1	-16.1
6.1296	15.4	57.9	-70.5
6.1324	15.6	57.6	-109.0
6.1352	15.3	57.5	-46.9
6.1380	15.3	57.4	-38.9
6.1408	15.5	57.2	-63.7
6.1436	15.6	57.1	-9.1
6.1463	15.4	56.9	-86.3
6.1491	15.3	56.7	-81.9
6.1519	15.2	56.3	-136.6
6.1547	15.4	56.2	-47.3
6.1575	15.4	56.0	-51.0
6.1603	15.3	56.1	10.5
6.1631	15.3	55.6	-168.1
6.1658	15.5	55.5	1.5
6.1686	15.4	55.5	-38.0
6.1714	15.2	55.2	-96.0

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 41 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.56M, W =0.21M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
6.1742	15.3	54.9	-111.0
6.1770	15.3	54.7	-48.0
6.1798	15.1	54.4	-118.0
6.1826	15.2	54.2	-69.4
6.1854	15.2	54.0	-78.4
6.1881	15.1	53.6	-150.4
6.1909	15.1	53.5	-38.4
6.1937	15.1	53.4	-4.0
6.1965	15.2	52.8	-204.6
6.1993	15.1	52.8	-17.9
6.2021	15.1	52.3	-9.4
6.2049	15.0	52.5	-116.5
6.2077	15.1	52.4	-29.1
6.2104	15.2	52.2	-52.4
6.2132	15.1	51.8	-152.5
6.2160	15.0	51.7	-25.9
6.2188	14.9	51.5	-79.8
6.2216	14.9	51.4	-50.9
6.2244	14.8	50.9	-179.9
6.2272	15.0	51.1	115.2
6.2300	15.0	50.6	-201.6
6.2327	14.9	50.4	-63.6
6.2355	15.0	50.2	-66.0
6.2383	14.8	50.1	-38.8
6.2411	14.9	50.1	-1.3
6.2439	14.9	49.7	-124.0
6.2467	15.0	49.7	-9.9
6.2495	14.8	49.3	-141.8
6.2523	14.7	48.9	-151.0
6.2550	14.7	49.1	67.1
6.2578	14.8	48.8	-94.0
6.2606	14.9	48.6	-45.8
6.2634	14.7	48.6	-35.0
6.2662	14.3	48.4	-43.0

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 41 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.56M, W =0.21M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
6.2690	14.7	48.4	-45.3
6.2718	14.6	48.2	-54.0
6.2745	14.8	47.5	-176.7
6.2773	14.8	47.7	22.2
6.2801	14.7	47.5	-100.4
6.2829	14.6	47.1	-112.2
6.2857	14.7	47.0	-48.1
6.2885	14.6	46.9	-47.8
6.2913	14.6	46.6	-113.8
6.2941	14.5	46.5	-37.3
6.2968	14.5	46.2	-73.1
6.2996	14.6	46.2	-11.6
6.3024	14.5	46.2	-15.2
6.3052	14.4	45.8	-137.2
6.3080	14.6	45.5	-84.1
6.3108	14.5	45.4	-32.3
6.3136	14.4	45.2	-80.5
6.3164	14.5	44.9	-91.1
6.3191	14.4	44.6	-136.8
6.3219	14.4	44.5	-25.6
6.3247	14.3	44.4	-31.8
6.3275	14.3	44.3	-32.5
6.3303	14.3	44.0	-104.7
6.3331	14.3	43.9	-21.9
6.3359	14.2	43.7	-89.7
6.3387	14.0	43.4	-129.1
6.3414	14.3	43.2	-38.9
6.3442	14.2	43.0	-71.8
6.3470	14.1	43.1	25.6
6.3498	14.1	42.9	-75.8
6.3526	13.9	42.7	-89.8
6.3554	14.1	42.4	-92.3
6.3582	14.2	42.2	-57.7
6.3610	14.1	42.0	-73.7

PRE-DIRECT COURSE TEST, 7 OCT 1982 3386 41 5

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 41 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.56M, W =0.21M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
6.3637	14.0	41.9	-37.7
6.3665	14.0	41.5	-142.1
6.3693	14.0	41.5	-0.0
6.3721	13.8	41.5	-34.1
6.3749	13.9	41.1	-111.5
6.3777	14.1	40.8	-69.7
6.3805	13.9	40.9	-16.6
6.3833	13.7	40.6	-98.9
6.3860	13.7	40.3	-100.6
6.3888	13.8	40.0	-102.1
6.3916	13.9	40.0	2.0
6.3944	13.7	39.9	-50.8
6.3972	13.8	39.6	-75.0
6.4000	13.8	39.3	-98.6
6.4028	13.7	39.3	-30.8
6.4055	13.7	39.2	-16.1
6.4083	13.7	39.0	-85.7
6.4111	13.8	38.9	-28.4
6.4139	13.7	38.5	-119.8
6.4167	13.6	38.3	-70.3
6.4195	13.7	38.1	-78.5
6.4223	13.6	38.0	-23.3
6.4251	13.6	37.7	-103.6
6.4278	13.4	37.5	-124.9
6.4306	13.5	37.3	-32.9
6.4334	13.7	37.2	-30.2
6.4362	13.4	37.0	-108.2
6.4390	13.3	36.8	-79.5
6.4418	13.5	36.5	-49.7
6.4446	13.4	36.4	-55.8
6.4474	13.4	36.1	-91.2
6.4501	13.4	36.0	-33.4
6.4529	13.4	36.0	1.4
6.4557	13.4	35.7	-113.3

PRE-DIRECT COURSE TEST, 7 OCT 1982
FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA
FRAGMENT 41 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG
APPARENT SIZE: L =0.56M, W =0.21M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
6.4585	13.3	35.5	-65.1
6.4613	13.2	35.5	-39.0
6.4641	13.1	35.2	-81.9
6.4669	13.3	35.0	-53.3
6.4697	13.1	35.0	-30.5
6.4724	13.0	34.7	-111.0
6.4752	13.1	34.5	-53.9
6.4780	13.2	34.3	-50.4
6.4808	13.0	34.2	-50.0
6.4836	13.1	34.0	-61.0
6.4864	13.0	33.9	-63.9
6.4892	12.9	33.6	-104.9
6.4920	13.0	33.5	-31.0
6.4947	13.0	33.4	-25.3
6.4975	13.0	33.2	-68.0
6.5003	13.0	32.9	-94.0
6.5031	12.8	32.8	-68.2
6.5059	12.8	32.6	-62.3
6.5087	12.9	32.2	-110.2
6.5115	12.9	32.4	65.4
6.5143	12.8	32.1	-129.6
6.5170	12.8	31.9	-57.0
6.5198	12.7	31.7	-90.7
6.5226	12.8	31.5	-50.6
6.5254	12.8	31.5	4.3
6.5282	12.5	31.5	-22.1
6.5310	12.7	31.3	-55.9
6.5338	12.7	30.9	-134.8
6.5365	12.7	30.8	-39.9
6.5393	12.5	30.6	-76.1
6.5421	12.5	30.4	-79.8
6.5449	12.6	30.2	-50.3
6.5477	12.3	30.1	-77.4
6.5505	12.5	29.9	-56.2

PRE-DIRECT COURSE TEST, 7 OCT 1982

FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 41 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.56M, W =0.21M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
6.5533	12.5	29.6	-62.4
6.5561	12.5	29.4	-62.7
6.5588	12.5	29.4	-6.6
6.5616	12.5	29.2	-65.7
6.5644	12.5	29.2	-32.8
6.5672	12.5	29.0	-45.5
6.5700	12.4	28.7	-130.4
6.5728	12.4	28.5	-52.8
6.5756	12.4	28.3	-61.8
6.5784	12.4	28.2	-31.2
6.5811	12.4	28.1	-34.7
6.5839	12.3	27.9	-90.3
6.5867	12.3	27.7	-55.4
6.5895	12.4	27.4	-82.2
6.5923	12.2	27.4	-35.3
6.5951	12.3	27.3	-31.6
6.5979	12.5	27.0	-70.0
6.6007	12.4	26.8	-60.6
6.6034	12.2	26.8	-23.5
6.6062	12.1	26.6	-93.9
6.6090	12.1	26.4	-39.4
6.6118	12.3	26.4	13.3
6.6146	12.1	26.1	-111.7
6.6174	12.2	25.8	-95.3
6.6202	12.2	25.6	-54.3
6.6230	12.2	25.3	-102.4
6.6257	12.1	25.5	57.1
6.6285	12.0	25.3	-106.8
6.6313	12.1	25.2	11.9
6.6341	12.1	24.9	-109.6
6.6369	12.2	24.9	-0.5
6.6397	12.1	24.7	-71.0
6.6425	12.0	24.4	-114.3
6.6453	12.1	24.3	-12.9

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 41 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.56M, W =0.21M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
6.6480	12.0	24.0	-119.2
6.6508	12.0	23.8	-45.6
6.6536	12.0	23.7	-43.1
6.6564	11.9	23.5	-65.9
6.6592	11.9	23.5	-17.8
6.6620	12.0	23.5	28.0
6.6648	12.0	23.2	-113.5
6.6675	12.1	22.9	-66.8
6.6703	11.9	23.0	-6.6
6.6731	11.9	22.7	-96.0
6.6759	11.9	22.4	-67.1
6.6787	11.8	22.4	-30.9
6.6815	12.1	22.2	-17.6
6.6843	11.9	21.9	-141.6
6.6871	12.0	21.8	9.1
6.6898	12.0	21.6	-80.4
6.6926	11.7	21.5	-68.3
6.6954	11.9	21.6	54.2
6.6982	12.0	21.4	-47.6
6.7010	12.1	21.0	-119.2
6.7038	12.0	21.0	-14.0
6.7066	11.7	21.2	17.7
6.7094	11.9	20.7	-123.8
6.7121	12.0	20.5	-53.8
6.7149	11.9	20.4	-12.6
6.7177	11.9	20.4	-38.7
6.7205	11.9	19.9	-123.2
6.7233	11.9	20.0	10.8
6.7261	11.8	19.9	-42.8
6.7289	11.8	19.7	-40.9
6.7317	11.9	19.4	-83.2
6.7344	11.9	19.4	-13.4
6.7372	11.9	19.5	20.1
6.7400	11.8	19.2	-85.4

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FRAGMENT TRAJECTORY FROM CAMERA F-3386 DATA

FRAGMENT 41 CAMERA F-3386 AZIMUTH OF U-AXIS 212.4 DEG

APPARENT SIZE: L =0.56M, W =0.21M STABILIZED

TIME (SEC)	U (M)	Z (M)	VELOCITY (M/SEC)
6.7428	11.8	18.9	-97.1
6.7456	11.9	18.5	-93.6
6.7484	11.9	18.6	24.2
6.7512	11.9	18.5	-47.7
6.7540	12.0	18.1	-104.8
6.7567	12.1	18.0	-3.2
6.7595	11.7	18.0	-62.4
6.7623	11.7	17.7	-83.6
6.7651	12.0	17.4	-39.7
6.7679	12.0	17.3	-19.0
6.7707	12.1	17.0	-81.9
6.7735	12.4	16.2	-158.0
6.7762	12.2	16.7	92.0
6.7790	12.1	16.3	-135.1
6.7818	12.3	15.6	-142.9

APPENDIX E

This appendix contains the analysis of the triangulated ground-based photographic data as perceived by the Physical Sciences Laboratory. The first line on the data page, on the far right hand side, indicates the fragment letter and page number. The second line presents the numbers of the cameras from which data were obtained for this analysis. The first section of data gives the position-time data for the fragment and the velocity of the fragment corresponding to each direction of motion. Also presented is the calculated total velocity, angle above the horizontal, and angle with respect to the test bed orientation. The second set of data (for the same fragment trajectory) lists the deviations of the measurements from each location, the error of the total velocity, and the locations of the cameras which were used in the computation.

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE A 1

DATA FROM: STA. F-3365 (FRAG. #1) AND STA. F-3386 (FRAG. #1)

POSITIONS, VELOCITIES, TRAJECTORY ANGLE DATA

TIME SECS	X FEET	Y FEET	Z FEET	V(X) F/S	V(Y) F/S	V(Z) F/S	V(T) F/S	THETA DEG	PHI DEG
.1000	2.5	25.7-	76.5						
.1028	2.4	26.4-	77.5	3.5	227.9-	524.7	572.1	66.5	270.9
.1056	2.6	27.0-	79.4						

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE A 2
DATA FROM: STA. F-3365 (FRAG. #1) AND STA. F-3386 (FRAG. #1)

TIME SECS	SIGMA (X) FEET	SIGMA (Y) FEET	SIGMA (Z) FEET	SIGMA (A) MIN	STATION DESIGNATION
.1000	.61	.78	.49	2.2	AC
.1028	1.39	1.78	1.11	5.0	AC
.1056	.15	.19	.12	.5	AC

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE B 1
DATA FROM: STA. F-3365 (FRAG. #2) AND STA. F-3386 (FRAG. #11)

POSITIONS, VELOCITIES, TRAJECTORY ANGLE DATA

TIME SECS	X FEET	Y FEET	Z FEET	V(X) F/S	V(Y) F/S	V(Z) F/S	V(T) F/S	THETA DEG	PHI DEG
.1333	24.7	19.1	66.0						
		.....							
.1611	29.8	22.9	75.4						
.1639	30.4	23.4	76.5	175.1	116.0	378.0	432.4	60.9	33.5
.1667	30.7	23.6	77.5	108.5	46.8	336.4	356.6	70.6	23.3
.1694	31.0	23.6	78.3	118.9	111.3	305.9	346.5	62.0	43.1
.1722	31.4	24.2	79.2	228.4	235.4	256.2	416.1	38.0	45.9
.1750	32.3	24.9	79.8	295.1	245.0	259.1	462.9	34.0	39.7
.1778	33.0	25.5	80.6						

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE B 2
DATA FROM: STA. F-3365 (FRAG. #2) AND STA. F-3386 (FRAG. #11)

TIME SECS	SIGMA (X) FEET	SIGMA (Y) FEET	SIGMA (Z) FEET	SIGMA (A) MIN	STATION DESIGNATION
.1333	1.01	1.32	.82	3.7	AC
	.....				
.1611	.75	.99	.61	2.8	AC
.1639	.10	.13	.08	.4	AC
.1667	.65	.86	.53	2.4	AC
.1694	.63	.83	.51	2.3	AC
.1722	.18	.24	.15	.7	AC
.1750	.59	.78	.48	2.2	AC
.1778	.30	.40	.25	1.1	AC

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE C 1
DATA FROM: STA. F-3365 (FRAG. #3) AND STA. F-3386 (FRAG. #10)

POSITIONS, VELOCITIES, TRAJECTORY ANGLE DATA

TIME SECS	X FEET	Y FEET	Z FEET	V(X) F/S	V(Y) F/S	V(Z) F/S	V(T) F/S	THETA DEG	PHI DEG
.1222	3.9	6.1	64.9						
.1250	4.1	6.1	65.9	32.3	57.9	330.3	336.9	78.6	60.9
.1278	4.1	6.4	66.7	7.5	61.1	365.7	370.9	80.4	83.0
.1306	4.1	6.4	67.9	9.0	29.9	394.9	396.1	85.5	73.3
.1333	4.1	6.6	68.9	6.2	44.4	393.1	395.7	83.5	82.0
.1361	4.2	6.7	70.1						
		.....							
.1472	4.2	7.0	73.5						
.1500	4.2	7.1	74.5	5.7	13.3-	348.0	348.3	87.6	293.1
.1528	4.2	6.9	75.5						
		.....							
.1694	4.6	7.6	81.0						

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE C 2
DATA FROM: STA. F-3365 (FRAG. #3) AND STA. F-3386 (FRAG. #10)

TIME SECS	SIGMA (X) FEET	SIGMA (Y) FEET	SIGMA (Z) FEET	SIGMA (A) MIN	STATION DESIGNATION
.1222	.28	.36	.23	1.0	AC
.1250	.45	.57	.36	1.6	AC
.1278	.92	1.15	.73	3.3	AC
.1306	1.04	1.31	.83	3.7	AC
.1333	1.28	1.62	1.02	4.6	AC
.1361	1.51	1.90	1.20	5.4	AC
	.....				
.1472	.46	.58	.37	1.6	AC
.1500	.39	.49	.31	1.4	AC
.1528	.70	.88	.56	2.5	AC
	.....				
.1694	.09	.12	.08	.3	AC

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE D 1

DATA FROM: STA. F-3365 (FRAG. #5) AND STA. F-3386 (FRAG. #8)

POSITIONS, VELOCITIES, TRAJECTORY ANGLE DATA

TIME SECS	X FEET	Y FEET	Z FEET	V(X) F/S	V(Y) F/S	V(Z) F/S	V(T) F/S	THETA DEG	PHI DEG
.1222	21.4-	7.8	66.6						
.1250	21.8-	7.9	67.7	185.0-	69.5	406.5	452.0	64.1	159.4
.1278	22.4-	8.1	68.9	229.1-	56.8	427.6	488.4	61.1	166.1
.1306	23.1-	8.2	70.1	206.3-	60.2	434.2	484.5	63.7	163.7
.1333	23.5-	8.5	71.3	137.5-	90.7	403.6	436.0	67.8	146.6
.1361	23.8-	8.7	72.4	132.7-	49.2	371.8	397.8	69.2	159.7
.1389	24.3-	8.7	73.3						
		.....							
.1500	25.7-	9.8	77.6						
.1528	26.2-	9.6	78.8						
		.....							
.1611	27.6-	10.0	81.9						
.1639	27.9-	10.1	83.2	148.4-	36.5	469.3	493.6	72.0	166.2
.1667	28.4-	10.2	84.5	133.2-	69.8	364.7	394.5	67.6	152.4
.1694	28.7-	10.5	85.2	145.9-	123.4	206.9	281.7	47.3	139.8
.1722	29.2-	10.9	85.7	140.8-	97.7	283.8	331.5	58.9	145.2
.1750	29.5-	11.0	86.8	34.8-	86.6	435.9	445.8	77.9	111.9
.1778	29.4-	11.3	88.1						

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE D 2
DATA FROM: STA. F-3365 (FRAG. #5) AND STA. F-3386 (FRAG. #8)

TIME SECS	SIGMA (X) FEET	SIGMA (Y) FEET	SIGMA (Z) FEET	SIGMA (A) MIN	STATION DESIGNATION
.1222	1.05	1.24	.81	3.6	AC
.1250	.92	1.09	.71	3.1	AC
.1278	.38	.45	.30	1.3	AC
.1306	.36	.42	.28	1.2	AC
.1333	.56	.66	.44	1.9	AC
.1361	.30	.35	.23	1.0	AC
.1389	.59	.69	.45	2.0	AC
	.....				
.1500	.54	.63	.41	1.8	AC
.1528	.37	.43	.28	1.2	AC
	.....				
.1611	.51	.59	.39	1.7	AC
.1639	.07	.08	.05	.2	AC
.1667	.34	.40	.26	1.1	AC
.1694	.30	.35	.23	1.0	AC
.1722	1.52	1.76	1.18	5.1	AC
.1750	1.54	1.78	1.19	5.1	AC
.1778	.58	.67	.45	1.9	AC

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE E 1

DATA FROM: STA. F-3365 (FRAG. #6) AND STA. F-3386 (FRAG. #11)

POSITIONS, VELOCITIES, TRAJECTORY ANGLE DATA

TIME SECS	X FEET	Y FEET	Z FEET	V(X) F/S	V(Y) F/S	V(Z) F/S	V(T) F/S	THETA DEG	PHI DEG
.1333	26.6	15.3	65.3						
		.....							
.1417	27.2	15.2	67.9						
		.....							
.1583	31.2	17.9	73.5						
		.....							
.1667	33.3	18.6	76.9						
.1694	33.6	18.7	77.8	119.5	97.3	275.2	315.4	60.8	39.2
.1722	33.9	19.2	78.4						

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE E 2
DATA FROM: STA. F-3365 (FRAG. #6) AND STA. F-3386 (FRAG. #11)

TIME SECS	SIGMA (X) FEET	SIGMA (Y) FEET	SIGMA (Z) FEET	SIGMA (A) MIN	STATION DESIGNATION
.1333	.57	.75	.46	2.1	AC
	.....				
.1417	1.02	1.35	.82	3.8	AC
	.....				
.1583	1.01	1.34	.82	3.8	AC
	.....				
.1667	.07	.10	.06	.3	AC
.1694	.01	.01	.01	.0	AC
.1722	.42	.56	.34	1.6	AC

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE F 1

DATA FROM: STA. F-3365 (FRAG. #18) AND STA. F-3386 (FRAG. #13)

POSITIONS, VELOCITIES, TRAJECTORY ANGLE DATA

TIME SECS	X FEET	Y FEET	Z FEET	V(X) F/S	V(Y) F/S	V(Z) F/S	V(T) F/S	THETA DEG	PHI DEG
.1861	44.1-	31.8-	74.1						
.1889	44.4-	32.1-	75.0	115.2-	98.0-	318.8	352.8	64.6	220.4
.1917	44.7-	32.3-	75.9	160.1-	79.1-	303.0	351.8	59.5	206.3
.1944	45.3-	32.5-	76.7	170.6-	78.9-	295.8	350.4	57.6	204.8
.1972	45.7-	32.8-	77.5	163.0-	99.4-	312.3	366.0	58.6	211.4
.2000	46.2-	33.1-	78.4	186.0-	102.3-	331.2	393.4	57.3	208.8
.2028	46.7-	33.3-	79.3	171.6-	77.1-	300.0	354.1	57.9	204.2
.2056	47.1-	33.5-	80.1						

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE F 2

DATA FROM: STA. F-3365 (FRAG. #18) AND STA. F-3386 (FRAG. #13)

TIME SECS	SIGMA (X) FEET	SIGMA (Y) FEET	SIGMA (Z) FEET	SIGMA (A) MIN	STATION DESIGNATION
.1861	.50	.57	.38	1.6	AC
.1889	.55	.63	.42	1.8	AC
.1917	.49	.56	.37	1.6	AC
.1944	.67	.77	.51	2.2	AC
.1972	1.17	1.33	.89	3.8	AC
.2000	1.16	1.31	.88	3.8	AC
.2028	.93	1.05	.70	3.0	AC
.2056	1.10	1.24	.83	3.6	AC

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE G 1

DATA FROM: STA. F-3382 (FRAG. #1) AND STA. F-3386 (FRAG. #2)

POSITIONS, VELOCITIES, TRAJECTORY ANGLE DATA

TIME SECS	X FEET	Y FEET	Z FEET	V(X) F/S	V(Y) F/S	V(Z) F/S	V(T) F/S	THETA DEG	PHI DEG
.0722	14.3	19.0-	63.9						
.0750	14.9	19.6-	65.5						
		.....							
.0861	17.0	22.2-	71.6						
.0889	17.3	22.9-	73.1						

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE G 2

DATA FROM: STA. F-3382 (FRAG. #1) AND STA. F-3386 (FRAG. #2)

TIME SECS	SIGMA (X) FEET	SIGMA (Y) FEET	SIGMA (Z) FEET	SIGMA (A) MIN	STATION DESIGNATION
.0722	.55	.58	.41	2.1	BC
.0750	.33	.36	.25	1.3	BC
	.....				
.0861	.38	.40	.28	1.4	BC
.0889	.49	.52	.37	1.9	BC

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE H 1
DATA FROM: STA. F-3382 (FRAG. #22) AND STA. F-3386 (FRAG. #38)

POSITIONS, VELOCITIES, TRAJECTORY ANGLE DATA

TIME SECS	X FEET	Y FEET	Z FEET	V(X) F/S	V(Y) F/S	V(Z) F/S	V(T) F/S	THETA DEG	PHI DEG
.8194	80.6-	25.9	42.6						
.8222	80.9-	25.6	42.8	56.0-	51.8-	36.4	84.5	25.5	222.8
.8250	81.0-	25.6	42.8	24.2-	34.6	22.2	47.7	27.7	125.0
.8278	81.1-	25.8	42.9	18.1-	12.0	12.3	25.0	29.6	146.4
.8306	81.1-	25.7	42.8	16.7	30.5-	1.6	34.8	2.7	298.8
.8333	81.0-	25.6	42.9	20.1	26.7	29.5	44.6	41.4	53.0
.8361	80.9-	25.8	43.0	13.9	5.0-	21.3	26.0	55.2	340.2
.8389	80.9-	25.6	43.0	13.2-	52.7-	12.3	55.7	12.8	255.9
.8417	81.0-	25.5	43.1	20.4-	12.9	31.9	40.0	52.9	147.7
.8444	81.0-	25.7	43.2	22.0	28.0	44.6	57.1	51.4	51.8
.8472	80.9-	25.7	43.3	12.9	16.0	20.9	29.4	45.5	51.0
.8500	80.9-	25.8	43.3	6.8	12.3	6.1-	15.3	23.4-	61.0
.8528	80.9-	25.7	43.3	25.9	13.8	43.6	52.6	56.0	28.1
.8556	80.8-	25.8	43.6	56.5-	55.6-	66.8	103.7	40.1	224.5
.8583	81.2-	25.4	43.6	29.4-	76.8-	8.6-	82.7	6.0-	249.1
.8611	80.9-	25.4	43.5	24.8	22.0-	45.5	56.3	53.9	318.4
.8639	81.0-	25.3	43.9	16.0-	6.4	72.8	74.8	76.7	158.2
.8667	81.0-	25.4	43.9	12.4	55.6	42.3	71.0	36.5	77.4
.8694	81.0-	25.6	44.1	11.7	2.6-	68.6	69.6	80.1	347.5
.8722	81.0-	25.4	44.3	.8	21.3-	35.3	41.2	58.9	272.2
.8750	81.0-	25.5	44.3						

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE H 2

DATA FROM: STA. F-3382 (FRAG. #22) AND STA. F-3386 (FRAG. #38)

TIME SECS	SIGMA (X) FEET	SIGMA (Y) FEET	SIGMA (Z) FEET	SIGMA (A) MIN	STATION DESIGNATION
.8194	.37	.45	.27	1.4	BC
.8222	.05	.06	.04	.2	BC
.8250	.33	.39	.24	1.2	BC
.8278	.15	.18	.11	.6	BC
.8306	.15	.18	.11	.6	BC
.8333	.08	.09	.06	.3	BC
.8361	.43	.52	.32	1.6	BC
.8389	.56	.67	.41	2.1	BC
.8417	.08	.10	.06	.3	BC
.8444	.08	.10	.06	.3	BC
.8472	.25	.30	.18	.9	BC
.8500	.18	.21	.13	.7	BC
.8528	.01	.01	.00	.0	BC
.8556	.02	.02	.01	.1	BC
.8583	.15	.18	.11	.6	BC
.8611	.20	.24	.15	.8	BC
.8639	.05	.06	.04	.2	BC
.8667	.60	.72	.44	2.3	BC
.8694	.49	.59	.36	1.8	BC
.8722	1.39	1.66	1.02	5.2	BC
.8750	1.35	1.61	.99	5.0	BC

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE I 1
DATA FROM: F-3365 (FRAG. #24), F-3382 (FRAG. #20), AND F-3386 (FRAG. #20)

POSITIONS, VELOCITIES, TRAJECTORY ANGLE DATA

TIME SECS	X FEET	Y FEET	Z FEET	V(X) F/S	V(Y) F/S	V(Z) F/S	V(T) F/S	THETA DEG	PHI DEG
.3083	7.8-	2.6-	72.5						
.3111	8.0-	2.5-	73.2	1.3	2.3	212.8	212.8	89.3	61.3
.3139	7.8-	2.5-	73.7	10.2	16.3-	88.8	90.9	77.8	302.0
.3167	7.9-	2.6-	73.7	28.4-	6.3	94.8	99.1	72.9	167.4
.3194	8.0-	2.5-	74.2	43.5-	11.5	208.7	213.5	77.8	165.1
.3222	8.2-	2.5-	74.8	5.4-	2.4-	180.2	180.3	88.1	204.3
.3250	8.0-	2.5-	75.2	19.0	33.1-	173.6	177.7	77.6	299.8
.3278	8.1-	2.7-	75.8	47.3-	8.2-	117.6	127.0	67.8	189.9
.3306	8.3-	2.6-	75.9	62.5-	19.0	70.6	96.2	47.2	163.1
.3333	8.4-	2.6-	76.2	17.4-	12.9-	174.1	175.5	82.9	216.5
.3361	8.4-	2.6-	76.8	15.5-	27.9-	175.7	178.5	79.7	241.0
.3389	8.5-	2.7-	77.2	18.4-	10.2-	140.9	142.5	81.5	209.0
.3417	8.5-	2.7-	77.6	12.3-	12.1	144.5	145.5	83.2	135.4
.3444	8.6-	2.7-	78.0	47.4-	19.7	186.4	193.4	74.6	157.4
.3472	8.8-	2.6-	78.7	55.3-	1.3-	195.0	202.7	74.2	181.3
.3500	8.9-	2.7-	79.1	21.6-	30.9-	134.8	140.0	74.4	235.0
.3528	8.9-	2.8-	79.4	16.4-	1.7	169.8	170.6	84.4	174.1
.3556	9.0-	2.7-	80.0	8.4-	33.7	180.1	183.4	79.1	103.9
.3583	8.9-	2.6-	80.4	6.9-	7.6	164.0	164.3	86.4	132.4
.3611	9.0-	2.6-	80.9	40.3-	32.7-	184.7	191.8	74.3	219.0
.3639	9.1-	2.8-	81.4	59.9-	35.1-	227.6	237.9	73.0	210.4
.3667	9.3-	2.8-	82.2	9.6-	34.3	167.7	171.5	78.0	105.7
.3694	9.2-	2.6-	82.4	29.9	40.1	85.8	99.3	59.8	53.3
.3722	9.2-	2.6-	82.7	24.5-	1.4	117.9	120.4	78.2	176.8
.3750	9.3-	2.6-	83.0	44.3-	41.3-	166.8	177.4	70.0	223.0
.3778	9.4-	2.8-	83.6	45.9-	39.8-	190.6	200.0	72.3	220.9
.3806	9.6-	2.8-	84.1	36.1-	26.5	132.9	140.2	71.4	143.7
.3833	9.6-	2.7-	84.3	4.9	2.8	129.5	129.7	87.5	29.9
.3861	9.6-	2.8-	84.8	17.3-	21.6-	138.4	141.1	78.7	231.3
.3889	9.7-	2.8-	85.1	55.5-	17.5-	96.7	112.9	59.0	197.5
.3917	9.9-	2.9-	85.3	23.9-	42.9-	168.5	175.5	73.7	240.9
.3944	9.8-	3.0-	86.0	1.7	25.9-	222.3	223.8	83.3	273.8

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE I 2

DATA FROM: F-3365 (FRAG. #24), F-3382 (FRAG. #20), AND F-3386 (FRAG. #20)

POSITIONS, VELOCITIES, TRAJECTORY ANGLE DATA

TIME SECS	X FEET	Y FEET	Z FEET	V(X) F/S	V(Y) F/S	V(Z) F/S	V(T) F/S	THETA DEG	PHI DEG
.3972	9.9-	3.0-	86.6	5.2	30.1	164.2	167.0	79.4	80.1
.4000	9.8-	2.9-	86.9						

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE I 3
DATA FROM: F-3365 (FRAG. #24), F-3382 (FRAG. #20), AND F-3386 (FRAG. #20)

TIME SECS	SIGMA (X) FEET	SIGMA (Y) FEET	SIGMA (Z) FEET	SIGMA (A) MIN	STATION DESIGNATION
.3083	.85	.92	.63	3.2	BC
.3111	1.85	2.02	1.38	6.9	BC
.3139	1.33	1.45	1.00	5.0	BC
.3167	.25	.27	.19	.9	BC
.3194	.61	.66	.46	2.3	BC
.3222	1.01	1.10	.76	3.8	BC
.3250	.70	.76	.52	2.6	BC
.3278	.24	.26	.18	.9	BC
.3306	.28	.30	.21	1.0	BC
.3333	.09	.10	.07	.3	BC
.3361	.15	.16	.11	.6	BC
.3389	.43	.47	.32	1.6	BC
.3417	.37	.40	.28	1.4	BC
.3444	.37	.41	.28	1.4	BC
.3472	.32	.34	.22	2.0	ABC
.3500	.34	.36	.24	2.1	ABC
.3528	.41	.42	.28	2.5	ABC
.3556	.42	.44	.29	2.6	ABC
.3583	.25	.26	.17	1.5	ABC
.3611	.26	.27	.18	1.6	ABC
.3639	.32	.33	.22	2.0	ABC
.3667	.39	.48	.31	1.4	AC
.3694	.41	.51	.33	1.4	AC
.3722	.11	.14	.09	.4	AC
.3750	.51	.63	.41	1.8	AC
.3778	.42	.51	.33	1.5	AC
.3806	.65	.79	.51	2.3	AC
.3833	.67	.81	.53	2.3	AC
.3861	.73	.89	.58	2.6	AC
.3889	1.08	1.32	.86	3.8	AC
.3917	1.07	1.31	.85	3.7	AC
.3944	.94	1.15	.75	3.3	AC

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE I 4
DATA FROM: F-3365 (FRAG. #24), F-3382 (FRAG. #20), AND F-3386 (FRAG. #20)

TIME SECS	SIGMA (X) FEET	SIGMA (Y) FEET	SIGMA (Z) FEET	SIGMA (A) MIN	STATION DESIGNATION
.3972	.88	1.07	.69	3.1	AC
.4000	1.12	1.37	.89	3.9	AC

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE J 1

DATA FROM: F-3365 (FRAG. #15), F-3382 (FRAG. #07), AND F-3386 (FRAG. #18)

POSITIONS, VELOCITIES, TRAJECTORY ANGLE DATA

TIME SECS	X FEET	Y FEET	Z FEET	V(X) F/S	V(Y) F/S	V(Z) F/S	V(T) F/S	THETA DEG	PHI DEG
.1833	9.0-	15.7-	79.4						
.1861	9.3-	15.7-	80.4	76.9-	63.6-	318.1	333.4	72.6	219.6
.1889	9.4-	16.0-	81.1	54.1-	74.3-	260.3	276.0	70.6	233.9
.1917	9.6-	16.1-	81.8	58.6-	54.0-	298.3	308.8	75.0	222.7
.1944	9.7-	16.3-	82.8	60.7-	84.1-	320.5	336.8	72.1	234.2
.1972	9.9-	16.6-	83.6						

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE J 2
DATA FROM: F-3365 (FRAG. #15), F-3382 (FRAG. #07), AND F-3386 (FRAG. #18)

TIME SECS	SIGMA (X) FEET	SIGMA (Y) FEET	SIGMA (Z) FEET	SIGMA (A) MIN	STATION DESIGNATION
.1833	.41	.42	.28	2.6	ABC
.1861	.81	1.00	.64	2.9	AC
.1889	.69	.85	.55	2.4	AC
.1917	1.09	1.34	.86	3.8	AC
.1944	.91	1.12	.72	3.2	AC
.1972	1.18	1.46	.94	4.2	AC

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE K 1
TRAJECTORY OF CENTER TOP OBJECT FROM STATIONS F-3365, F-3382, AND F-3386

POSITIONS, VELOCITIES, TRAJECTORY ANGLE DATA

TIME SECS	X FEET	Y FEET	Z FEET	V(X) F/S	V(Y) F/S	V(Z) F/S	V(T) F/S	THETA DEG	PHI DEG
.0139	7.2-	4.3-	47.7						
.0167	8.4-	5.0-	52.9	418.6-	277.4-	1793.9	1862.8	74.4	213.5
.0194	9.5-	5.8-	57.6	334.6-	234.9-	1627.6	1678.2	75.9	215.1
.0222	10.3-	6.4-	61.9	300.6-	207.8-	1519.9	1563.2	76.5	214.7
.0250	11.2-	7.0-	66.1	70.3-	30.6-	1446.5	1448.5	87.0	203.5
.0278	10.7-	6.5-	70.0						

PRE-DIRECT COURSE, 7 OCT 1982 ----- MULTIPLE-STATION FRAGMENT TRAJECTORY DATAPAGE K 2
TRAJECTORY OF CENTER TOP OBJECT FROM STATIONS F-3365, F-3382, AND F-3386

TIME SECS	SIGMA (X) FEET	SIGMA (Y) FEET	SIGMA (Z) FEET	SIGMA (A) MIN	STATION DESIGNATION
.0139	.68	.74	.50	2.6	BC
.0167	.31	.33	.21	1.9	ABC
.0194	.41	.43	.28	2.5	ABC
.0222	.32	.33	.22	2.0	ABC
.0250	.30	.31	.20	1.8	ABC
.0278	2.36	2.02	.42	1.8	AB

APPENDIX F

This appendix contains the results of the ground search and survey. The first column identifies the fragment number, the second column gives the azimuth of the fragment location ($\pm 1^{o}$), the third column presents the ground range of the recovered fragment ($\pm$ 1 ft), and finally, the last column presents general comments on the description of the recovered fragment.

ITEM	AZIMUTH DEGREES	GROUND RANGE (FEET)	COMMENTS
1	1	47	4x1 1/2" angle
2	1	54	20" long channel "J1"
3	5	26	21" long channel
4	9	16	7x4" steel plate
5	9	200	24" long channel "L4"
6	14	46	2x4" steel plate
7	15	54	3x4" steel plate
8	18	29	2x3 1/2" angle
9	18	34	4" long channel
10	18	124	2x4" steel plate
11	19	15	7" long angle
12	20	24	1x2" steel plate
13	29	54	2x1" steel plate
14	37	36	20" long channel, white
15	37	347	"0" ring from top of tower
16	49	89	6" long channel "K1"
17	49	178	3x3" steel plate
18	52	29	3x4" angle
19	54	24	1x3" steel plate
20	58	215	1/2" cable, 50 ft long
21	58	404	2x6" channel
22	59	277	2 ground wire clamps
23	63	45	38" long angle
24	64	120	48" long angle
25	64	262	1 ground wire clamp
26	66	25	6" long channel
27	71	207	1x3" steel plate
28	72	23	16" long channel "A4"
29	80	335	1x2" steel plate
30	82	152	6x9" lower flange plate
31	84	97	24" long channel
32	85	118	1x3" steel plate
33	86	59	4x2" steel plate
34	93	309	4x2" channel
35	94	27	5" long angle
36	108	231	2" ball of steel
37	112	238	2x3" steel plate
38	112	307	1x2" steel plate
39	112	340	8" long channel "C4"
40	112	416	13" long channel
41	113	340	2x2" steel plate
42	114	61	9" long angle
43	118	196	15" long channel "J4"
44	120	18	24" long channel
45	125	57	4" long angle
46	130	117	4x4" steel plate
47	136	141	2x4" steel plate
48	138	95	2x2" steel plate
49	141	13	2x2" steel plate
50	141	142	2x4" steel plate
51	142	74	22" long channel "J3"
52	143	242	3/4" cable with clamp, 1 ft long

ITEM	AZIMUTH DEGREES	GROUND RANGE (FEET)	COMMENTS
53	144	231	6" long channel
54	145	8	2x4" steel plate
55	149	106	2x2" steel plate
56	152	152	2x4" steel plate
57	152	578	24" long copper cable
58	153	155	10 ft long copper cable
59	153	165	15 ft long copper cable
60	153	658	18"long copper cable
61	156	7	3x2" steel plate
62	156	299	4" long channel "I3"
63	159	125	3x5" steel plate
64	160	488	2" long angle
65	162	109	8" long angle
66	167	143	10" long channel
67	168	10	7" long channel
68	169	292	2x3" steel plate
69	171	323	22" long channel, white
70	171	406	7" long channel
71	173	120	24" long upper pipe
72	173	130	2x4" steel
73	179	45	3" long channel "D2"
74	180	115	6" long angle
75	180	435	9" long channel
76	180	517	20" long channel "C3"
77	182	310	3" long angle
78	183	409	6" long side off channel
79	184	417	7" long channel "I3"
80	187	43	2x3" angle
81	188	454	3x2" steel plate
82	189	666	16" long channel "H3"
83	190	43	2x3" angle
84	190	236	4" long channel "C3"
85	191	44	2x4" angle
86	193	263	guy cable holder
87	193	486	4x2" steel plate
88	196	560	3/4" steel washer
89	196	781	1x2" channel
90	198	567	9" long channel
91	201	9	1x4" steel plate
92	201	482	1x3" steel plate
93	210	1350	6" long channel "3"
94	212	627	9x5" upper pipe
95	213	11	4" long plate
96	213	13	5" angle
97	213	68	1x1" angle
98	213	73	2" long channel
99	213	1700	3/4" nut
100	214	306	10x10" upper steel pipe
101	215	320	2x5" steel plate
102	215	359	24" long tether cable with clamp
103	217	491	2x3" steel plate
104	222	56	7" long angle